6(a) - Baseband Troubleshooting and Manual Tuning Guide

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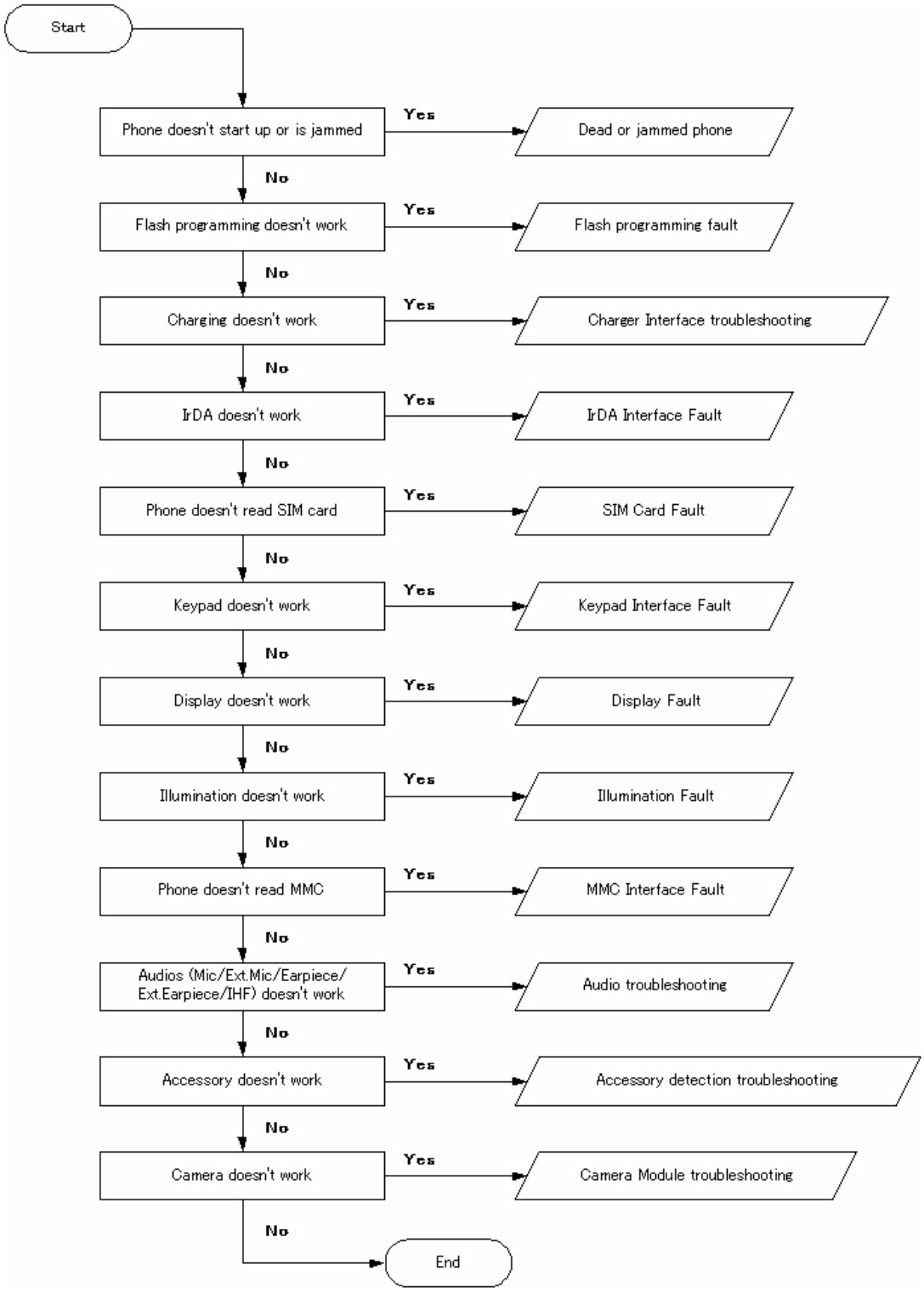
Introduction to NHL-10 troubleshooting

This document is intended to be a guide for localizing and repairing electrical faults in the NHL-10 device. The fault repairing is divided into troubleshooting paths.

The following diagrams describe baseband troubleshooting.

Figure 1: Main Troubleshooting Diagram



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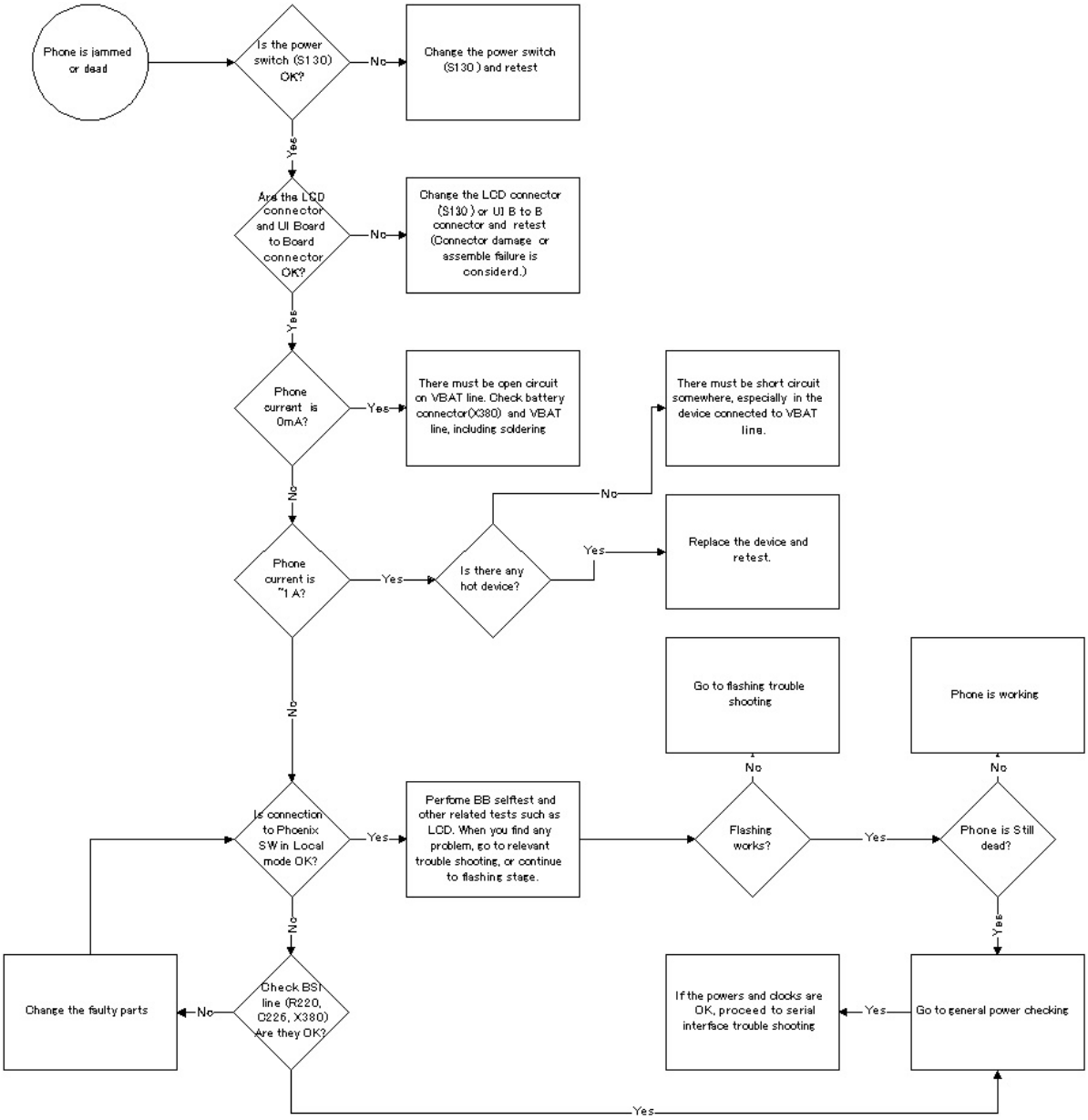
Dead or jammed phone

Figure 2: Phone is jammed or dead


Phone is jammed or dead
Is the power switch (S130) OK?
No
Change the power switch (S130) and retest
Yes
Are the LCD connector and UI Board to Board connector OK?
No
Change the LCD connector (S130) or UI B to B connector and retest (Connector damage or assemble failure is considerd.)
Yes
Phone current is 0mA?
Yes
There must be open circuit on VBAT line. Check battery connector(X380) and VBAT line, including soldering
No
There must be short circuit somewhere, especially in the device connected to VBAT line.
No
Phone current is "1 A?
Yes
Is there any hot device?
Yes
Replace the device and retest.
No
Go to flashing trouble shooting
Phone is working
No
No
Is connection to Phoenix S/W in Local mode OK?
Yes
Perfome BB selftest and other related tests such as LCD. When you find any problem, go to relevant trouble shooting, or continue to flashing stage.
Flashing works?
Yes
Phone is Still dead?
Yes
No
Change the faulty parts
No
Check BSI line (R220, C226, X380) Are they OK?
If the powers and clocks are OK, proceed to serial interface trouble shooting
Yes
Go to general power checking
Yes

BB Selftest tools

“Selftest failed. Contact service.” on display

This fault means that the software is able to run and thus the watchdog of UEM can be served.

Selftest functions are executed when the phone is powered on, and if one or more selftest functions fail, the message **“Selftest failed. Contact service.”** is shown on the display.

MCU selftest cases can be split into two categories: The ones that are executed during power up and the ones that are executed only with a PC connected. These tests and the items included are as follows:

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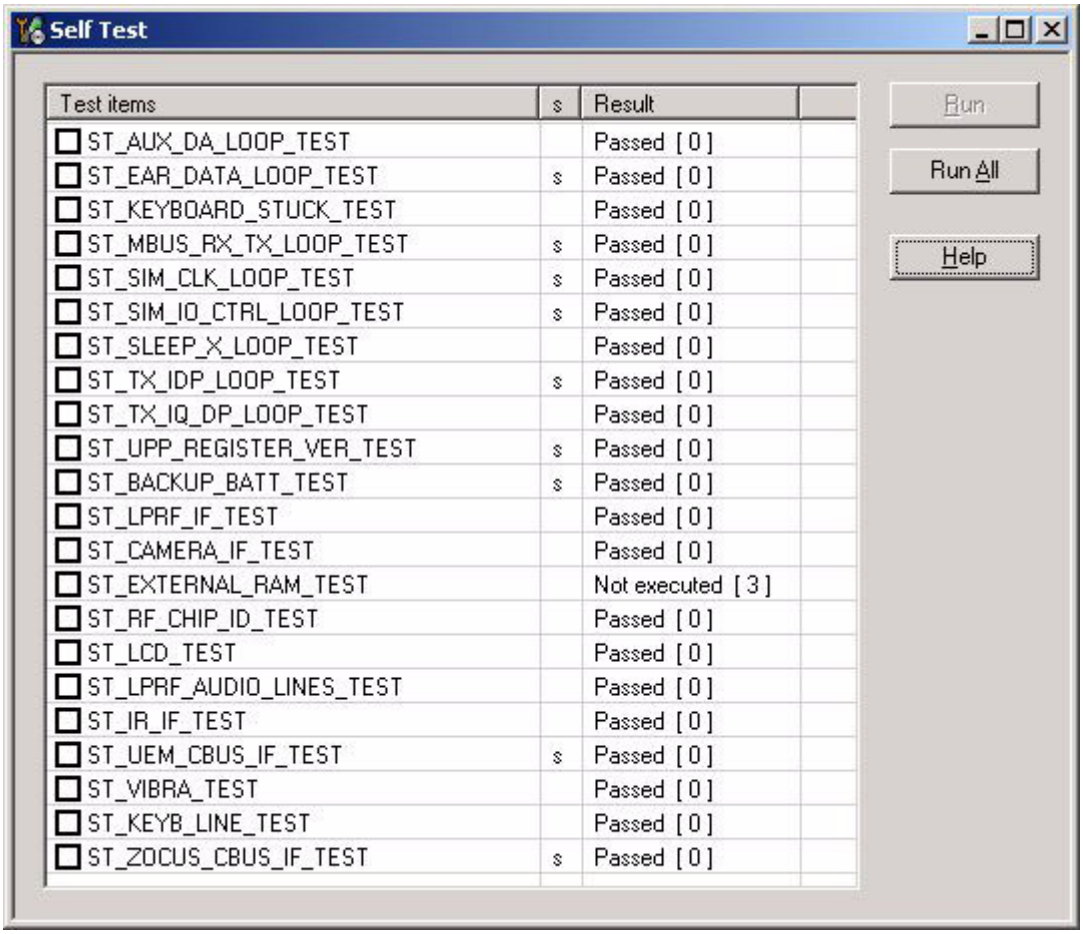
Figure 3: BB self test items



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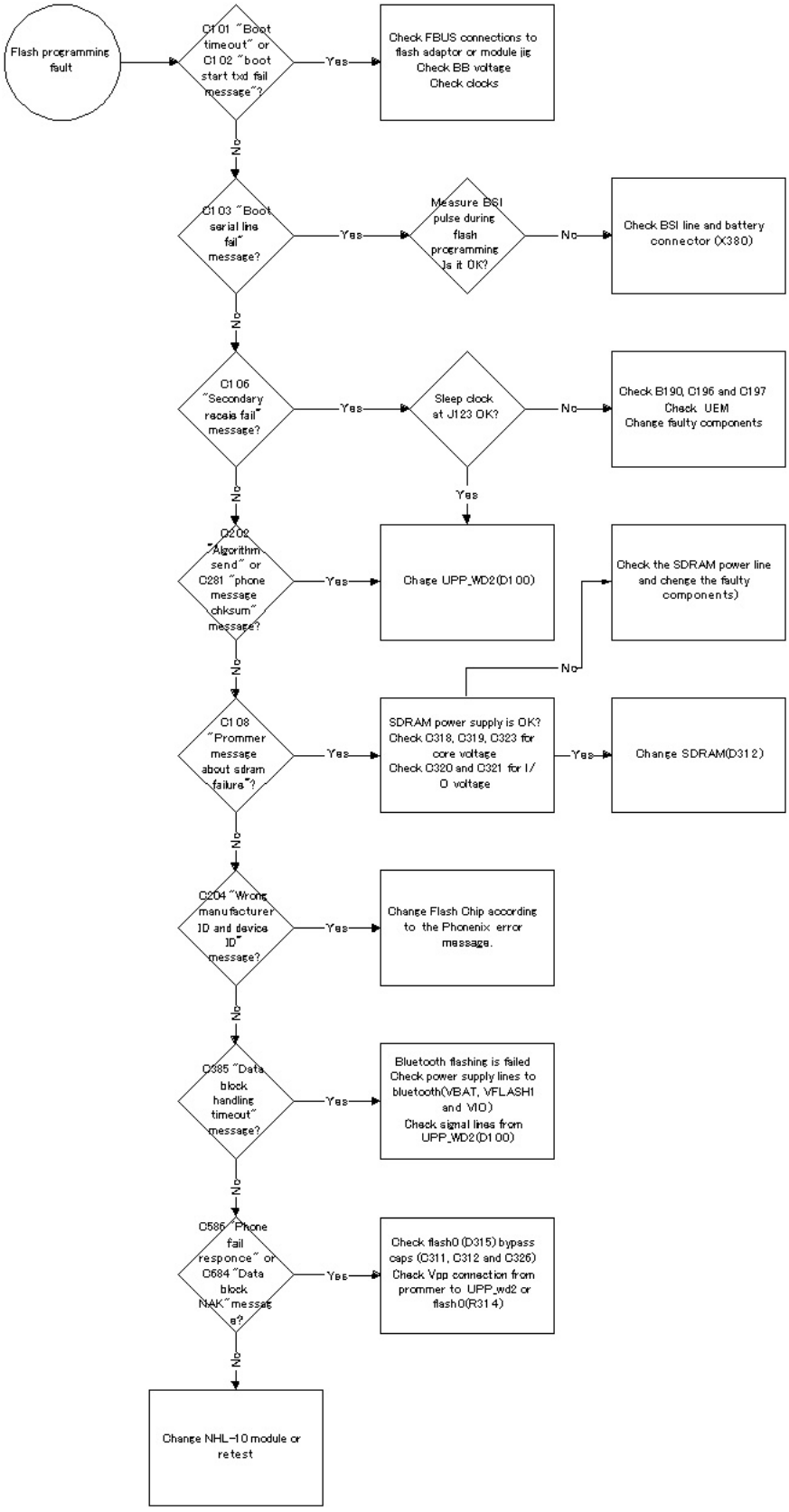
Flash programming fault

Figure 4: Flashing troubleshooting


Flash programming fault
C101 "Boot timeout" or C102 "boot start txd fail message"?
Yes
Check FBUS connections to flash adaptor or module jig
Check BB voltage
Check clocks
No
C103 "Boot serial line fail" message?
Yes
Measure BSI pulse during flash programming Is it OK?
No
Check BSI line and battery connector (X380)
No
C106 "Secondary racais fail" message?
Yes
Sleep clock at J123 OK?
No
Check B190, C196 and C197
Check UEM
Change faulty components
Yes
No
C202 "Algorithm send" or C281 "phone message chksum" message?
Yes
Chage UPP_WD2(D100)
Check the SDRAM power line and chenge the faulty components)
No
No
C108 "Prommer message about sdram failure"?
Yes
SDRAM power supply is OK?
Check C318, C319, C323 for core voltage
Check C320 and C321 for I/O voltage
Yes
Change SDRAM(D312)
No
C204 "Wrong manufacturer ID and device ID" message?
Yes
Change Flash Chip according to the Phonenix error message.
No
C385 "Data block handling timeout" message?
Yes
Bluetooth flashing is failed
Check power supply lines to bluetooth(VBAT, VFLASH1 and VIO)
Check signal lines from UPP_WD2(D100)
No
C586 "Phone fail responce" or C684 "Data block NAK" messag e?
Yes
Check flash0 (D315) bypass caps (C311, C312 and C326)
Check Vpp connection from prommer to UPP_wd2 or flash0(R314)
No
Change NHL-10 module or retest

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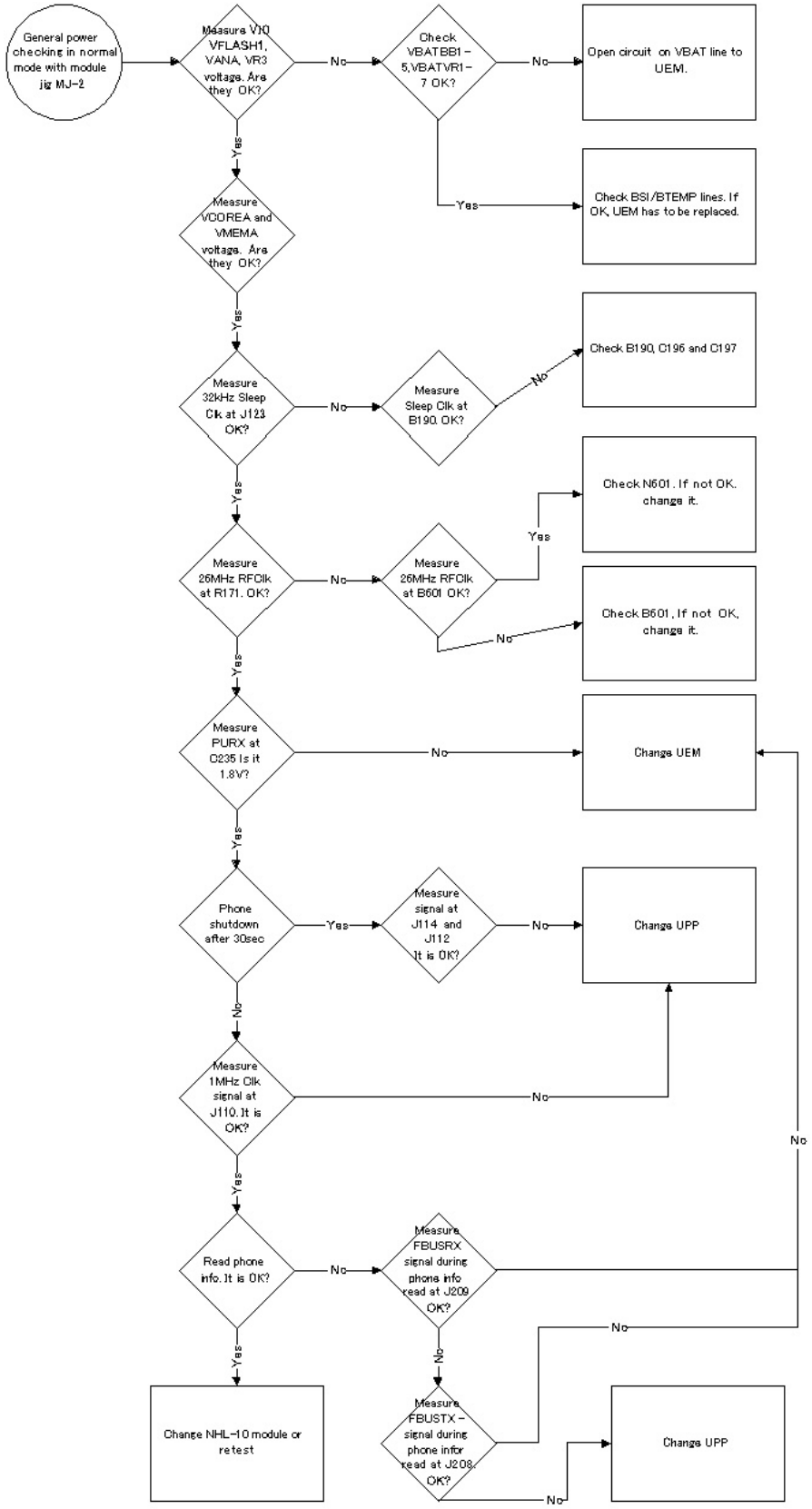
General Power checking

Figure 5: General Power check



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Baseband serial interface troubleshooting

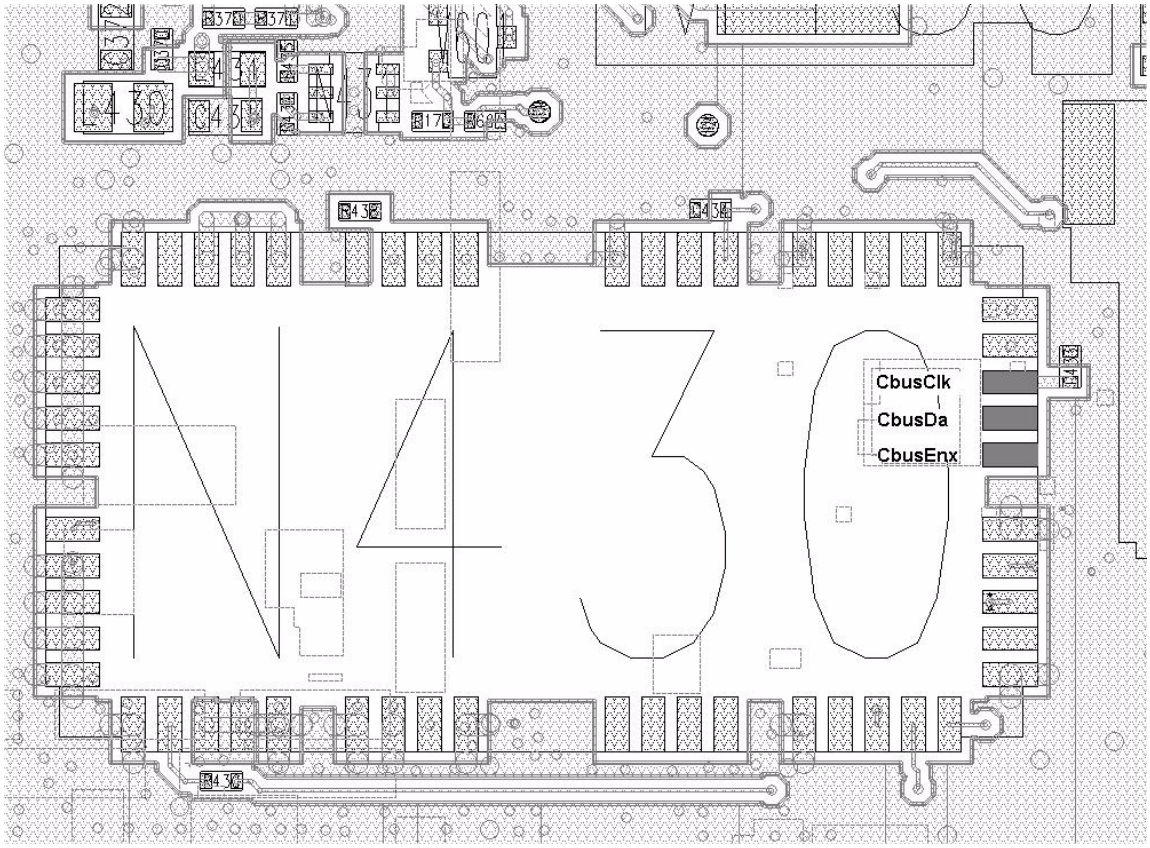
CBUS

CBUS is a three wire serial interface between the main baseband components. The bus consists of data, clock and bus_enable signals. In NHL-10 the bus is connected from UPP_WD2 to UEM and the BT module. UPP_WD2 takes care of controlling the traffic on the bus.

If the interface is faulty from the UPP WD2's end the phone will not boot properly as powering configurations do not work. Traffic on the bus can be monitored from three pins on the BT module.

Pins are shown below.

Figure 6: CBUS test points



CBUS traffic is shown in the figure below (Read command to Zocus, LM3819, N380).

CbusClk is connected to Ch1, Cbus Da to Ch2 and CbusEnx to Ch3.

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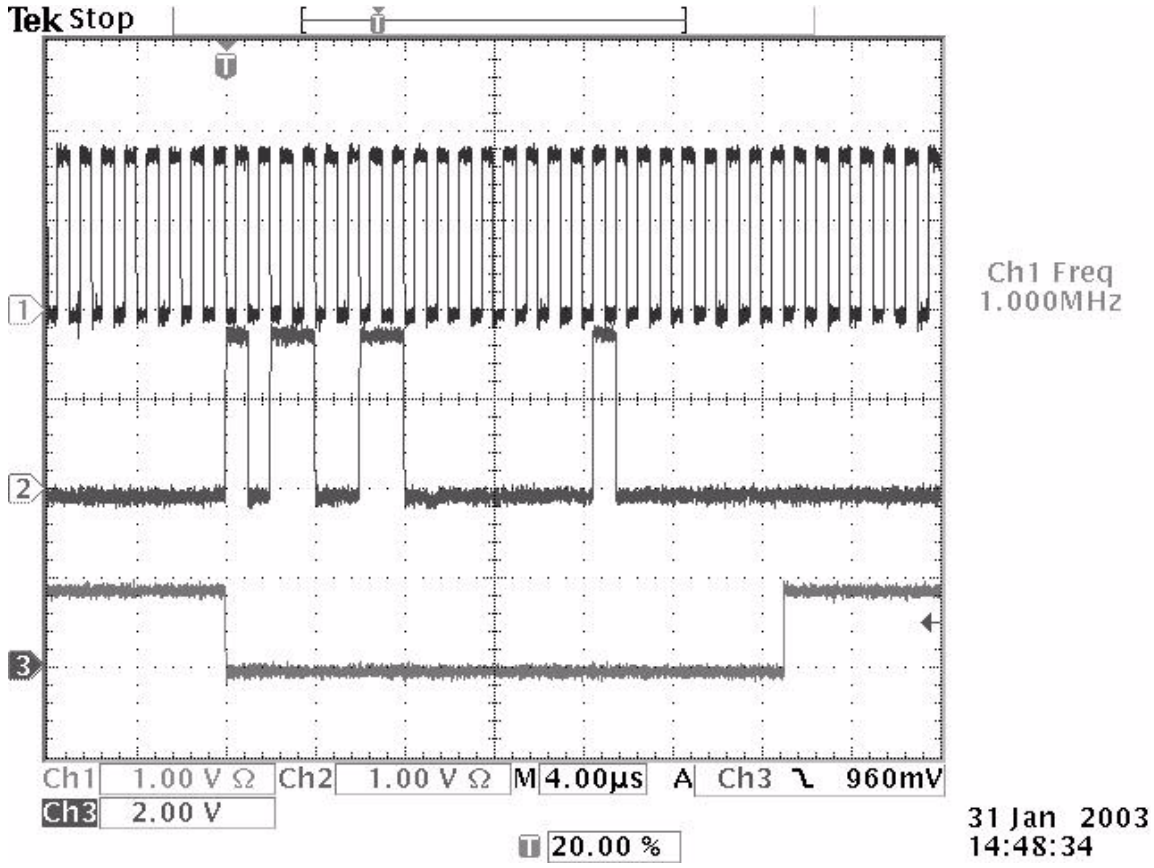
Figure 7: CBUS waveform



If you are able to get the phone to boot up and can reach Phoenix BB self tests it is possible to test the functionality of each component attached to Cbus. Use:

- ST_UEM_CBUS_IF_TEST to test UEM Cbus interface
- ST_LPRF_IF_TEST to test Bluetooth Cbus interface
- ST_ZOCUS_CBUS_IF_TEST to test Zocus Cbus interface

If an error is found testing any of the above components you should replace or re-solder the failing component.

FBUS

FBUS is a two wire RX and TX interface between UPP and flash/test interface. The bus goes through UEM, which adjusts the voltage levels to suit UPP_WD2. The interface voltage level on the phone flash/test pad pattern is 2.78V and on the UPP WD2 end it is 1.8V.

The functionality of this interface should not affect the device boot into NORMAL, LOCAL nor TEST modes. Phoenix tests can be performed through the MBUS interface in case of a failure in FBUS interface. Flashing is not possible if there is a problem in FBUS interface.

MBUS

MBUS is a two-wire RX and TX interface between UPP and UEM. From UEM the interface continues to flash/test interface as a one-wire interface. UEM adjusts the voltage levels.

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The interface voltage level on the phone flash/test pad pattern is 2.78V and on the UPP WD2 end it is 1.8V. The MBUS traffic between UPP WD2 and UEM can be tested with PHOENIX (ST_MBUS_RX_TX_LOOP_TEST). Flashing is not possible if there is a problem in MBUS.

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Charger Interface troubleshooting

Figure 8: Not charging on display

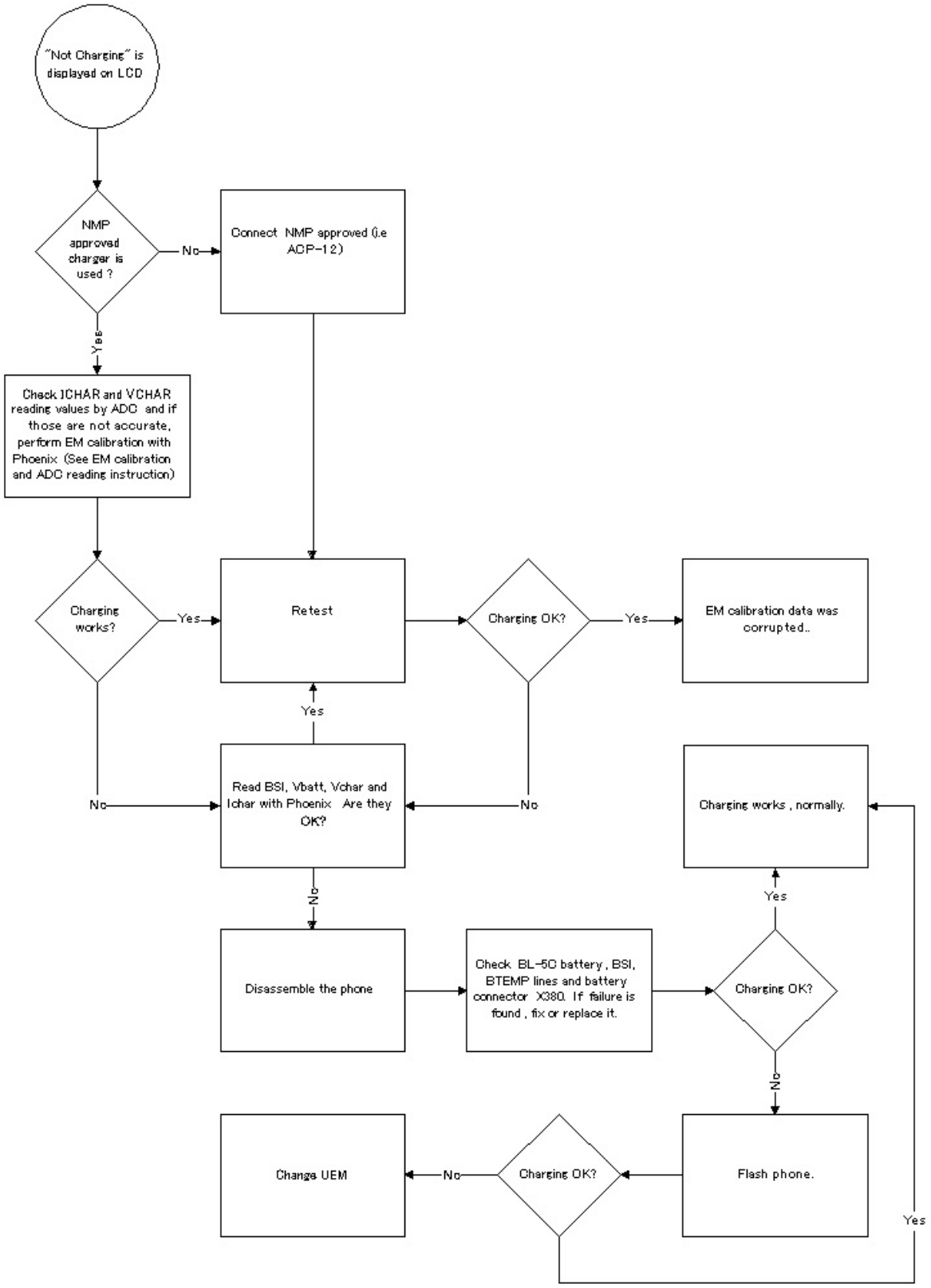
"Not Charging" is displayed on LCD
NMP approved charger is used ?
No
Connect NMP approved (i.e ACP-12)
Yes
Check ICHAR and VCHAR reading values by ADC and if those are not accurate, perform EM calibration with Phoenix (See EM calibration and ADC reading instruction)
Charging works?
Yes
Retest
Charging OK?
Yes
EM calibration data was corrupted..
Yes
No
Read BSI, Vbatt, Vchar and Ichar with Phoenix Are they OK?
No
Charging works , normally.
Yes
No
Disassemble the phone
Check BL-5C battery , BSI, BTEMP lines and battery connector X380. If failure is found , fix or replace it.
Charging OK?
No
Change UEM
No
Charging OK?
Flash phone.
Yes

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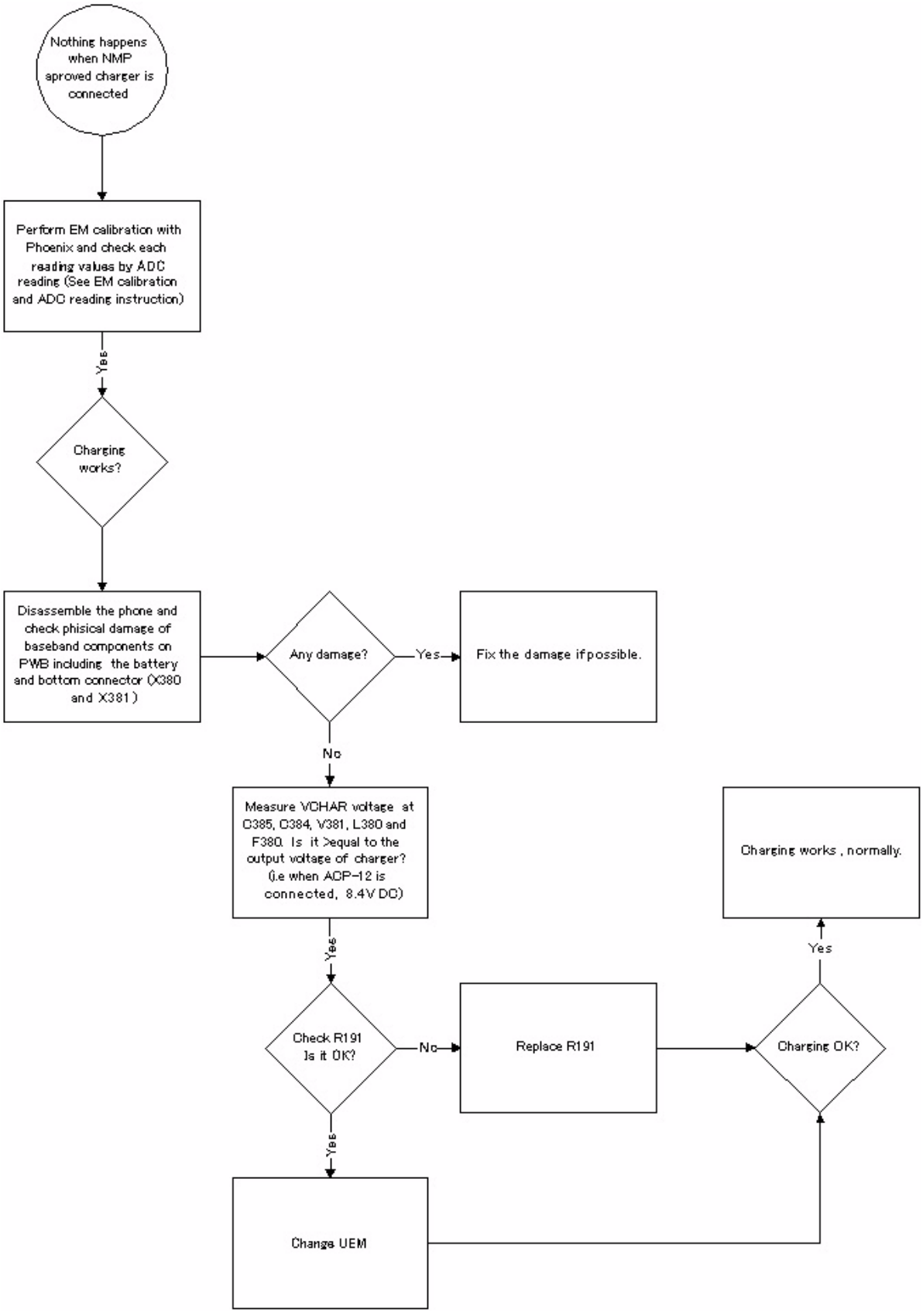
Figure 9: Charger nothing happened


Nothing happens when NMP aprowed charger is connected
Perform EM calibration with Phoenix and check each reading values by ADC reading (See EM calibration and ADC reading instruction)
Yes
Charging works?
Disassemble the phone and check phisical damage of baseband components on PWB including the battery and bottom connector (X380 and X381)
Any damage?
Yes
Fix the damage if possible.
No
Measure VCHAR voltage at C385, C384, V381, L380 and F380. Is it >equal to the output voltage of charger? (i.e when ACP-12 is connected, 8.4V DC)
Yes
Check R191 Is it OK?
No
Replace R191
Charging OK?
Yes
Charging works , normally.
Yes
Change UEM

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Energy management calibration

During energy management calibration, the A/D converter, BSI, Btemp, Battery voltage, Charger voltage and Charger current are calibrated. For detailed information and instructions see EM-calibration instructions in the service manual.

Troubleshooting tips

ADC-offset over limits

Inspect the BSI line, connectors (hotbar and board to board connector) and components in it (Capacitor C226, ASIP R385, Pull-up resistor R220). If these are OK, change UEM.

BSI Gain over limits

Inspect the BSI line, connectors (hotbar and board to board connector) and components in it (Capacitor C226, ASIP R385, Pull-up resistor R220). If these are OK, change UEM.

Vbatt offset and Gain

Inspect Vbatt lines and components in it.

Vchar over limits

Inspect components that are connected Vchar line: Filtering capacitors C384, C385, TVS V381, L380 and Fuse F380. If those are OK, change UEM.

Ichar over limits

Inspect components that are connected Vchar line: Filtering capacitors C384, C385, TVS V381, L380 and Fuse F380. If those are OK, first change the current sense resistor (R190), if calibration is not still successful change UEM.

Calibration can be checked using ADC-reading. Known voltages, currents and resistances are fed and read by ADC-reading, read values and known values can be compared.

ADC-reading

Divided and scaled battery voltage, Charger voltage, Charger current and BSI values can be read by this tool. Read values a few times before you can be sure that results are accurate.

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Figure 10: ADC-reading view

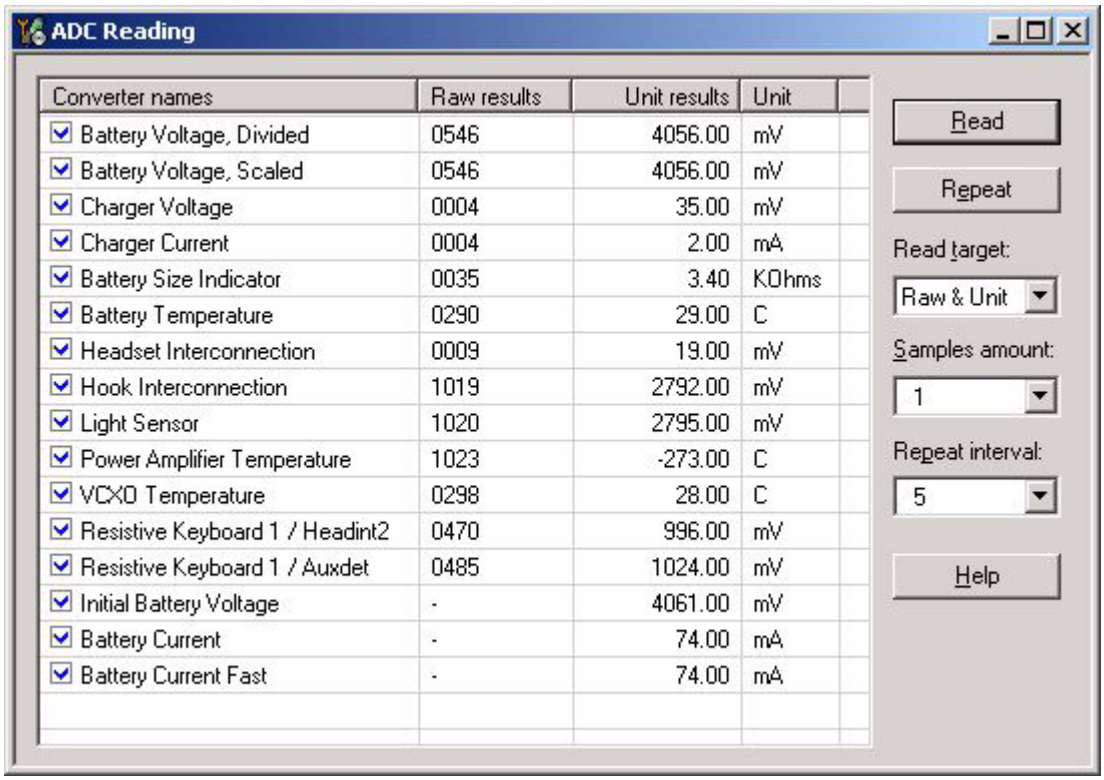

Table 1: Maximum tolerances

Reading	Check point	Tolerance
Vbatt SCAL_	4.2V	±25mV
Vchar	8.4V	±40mV
Ichar	500mA	±20mV
BSI	75k (BL-5C)	±1.3kohm
Btemp	273K (47k)	±5K

Backup battery

Symptom of backup battery fault is:

Real Time Clock loses the correct time during a short main battery removal.

The same symptom can also be seen when the backup battery is empty. About 5 hours is needed to fully charge the backup battery in the device.

Note: The backup battery is charged only at the same time with main battery charging. Or when the device is in LOCAL or TEST mode.

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Always check the backup battery visually for any leakage or any other visual defect.

Check that the backup battery is correctly mounted in the device before closing the cover.

Check with Phoenix that the backup battery is OK.

Measure the voltage of the backup battery

- Normal operation when the voltage is > 2.0V
- Fully charged when the voltage is about 3.2V

Enable backup battery charging. (Start to charge the main battery or boot the device to LOCAL or TEST mode.)

Measure the voltage of the backup battery during charging, it should arise if it is not 3.2V, yet.

When the voltage is over 2.0V for sure, check the backup battery with Phoenix.

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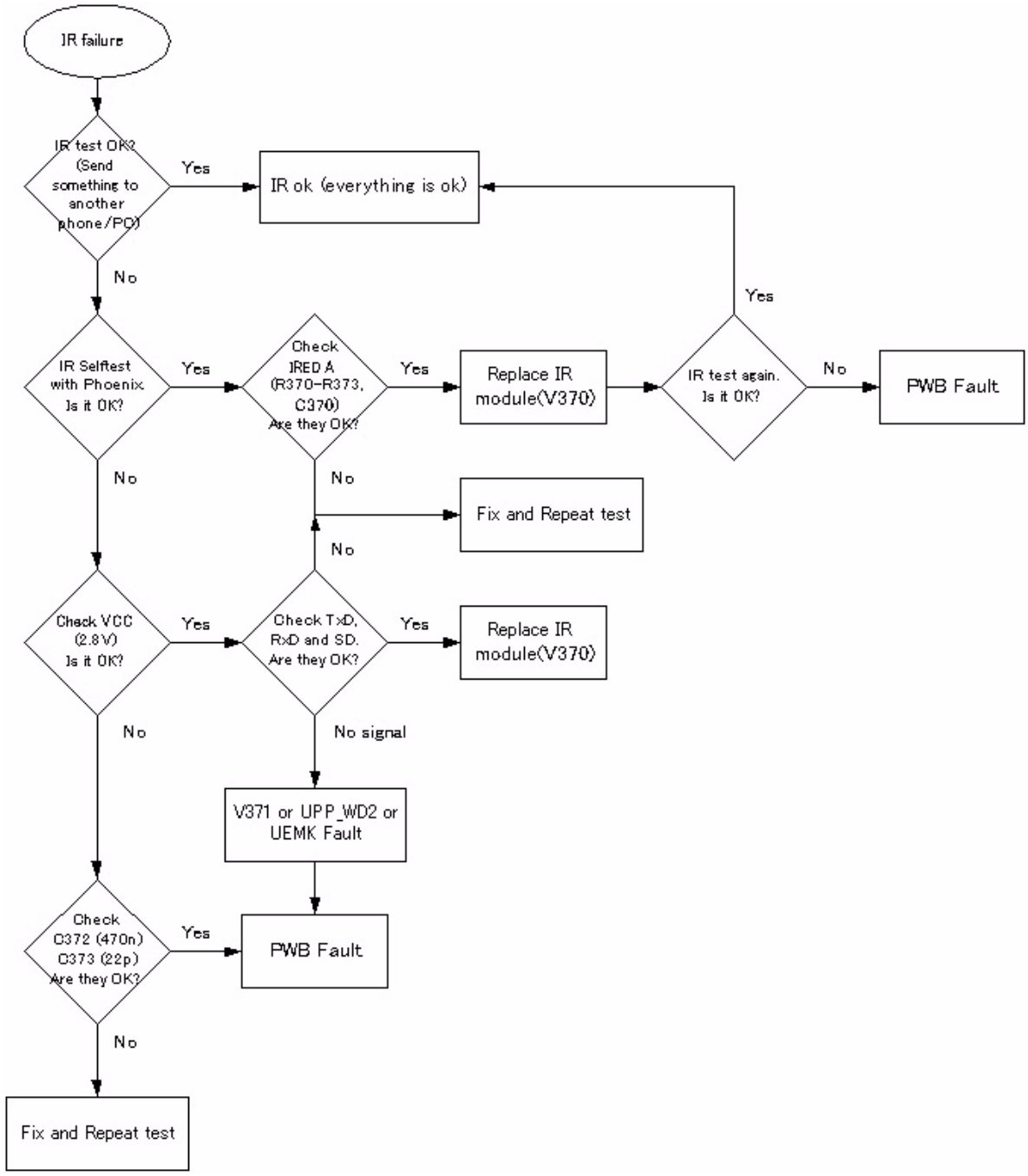
IrDA Interface Fault

At this point it is supposed that the problem is in the HW.

Figure 11: IrDA interface troubleshooting



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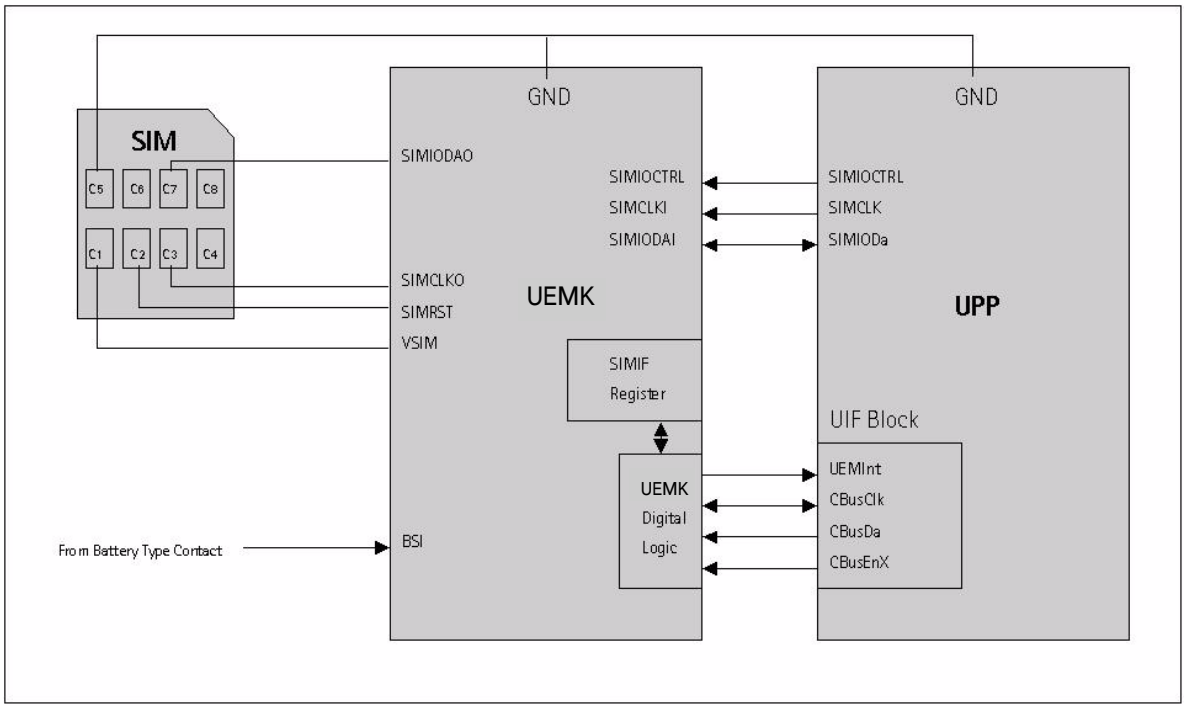
SIM Card Fault

The whole SIM interface is located in two chips, UPP_WD2 and UEMK. UEMK contains the SIM interface logic level shifting. UPP_WD2 provides SIMClk through UEMK to the SIM. The SIM interface supports both 3V and 1.8V SIMs. There is an EMIF component (3 Lines EMI filter) between the SIM card and UEMK, which isn't shown in the below picture.

Figure 12: UPP_WD2 and UEMK SIM connections



The SIM power up/down sequence is generated in the UEMK. This means that the UEMK generates the RST signal to the SIM. The card detection is taken from the BSI signal, which detects the removal of the battery. Monitoring of the BSI signal is done by a comparator inside UEMK. The threshold voltage is calculated from the battery size specifications.

First the SW attempts to power up the SIM with 1.8V. If this does not succeed, power up is repeated with VSIM switched to 3V.

The data communication between the card and the phone is asynchronous half duplex. The clock supplied to the card is in GSM system 1.083MHz or 3.25MHz. The data boud rate is SIM card clock frequency divided by 372 (by default), 64, 32 or 16.

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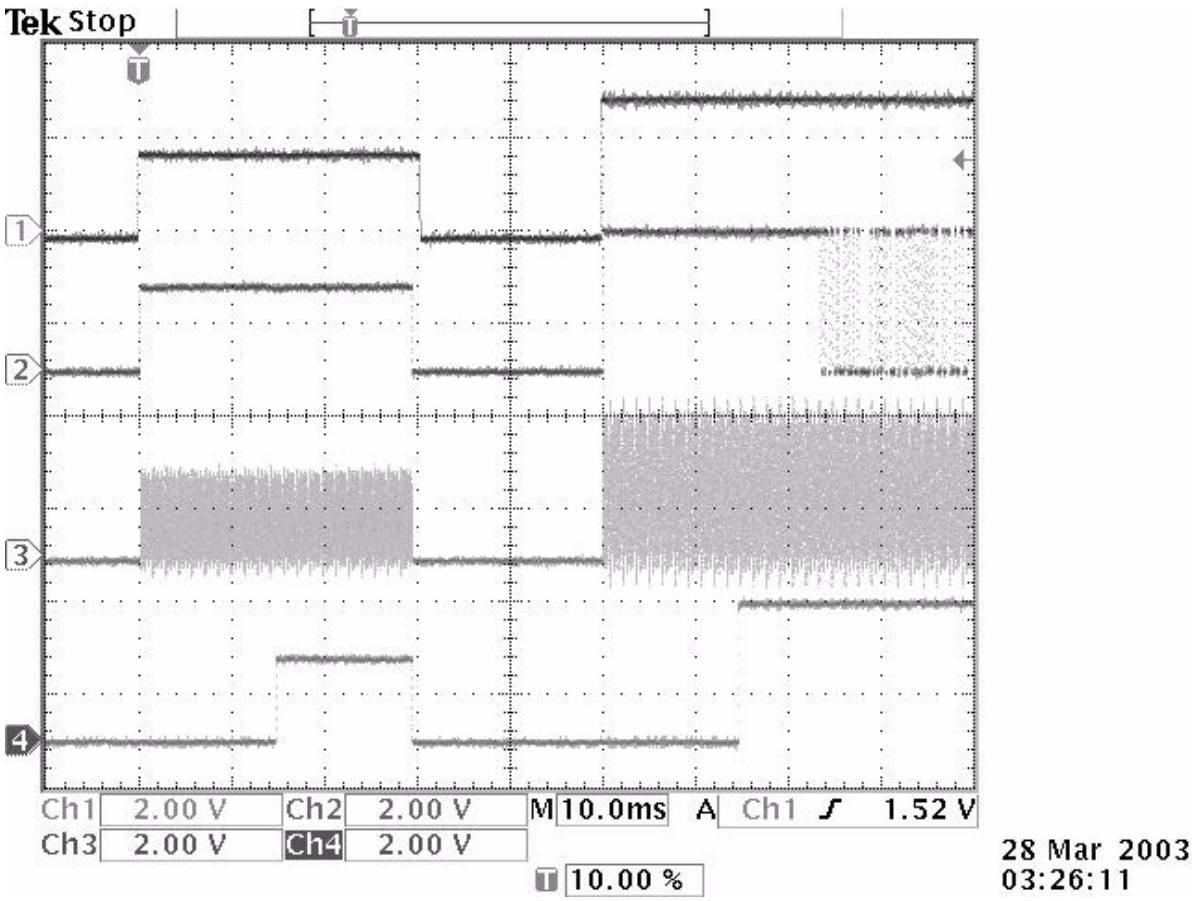
Figure 13: SIM Power up waveform



Ch1: VSIM

Ch2: I/O

Ch3: Clock

Ch4: Reset

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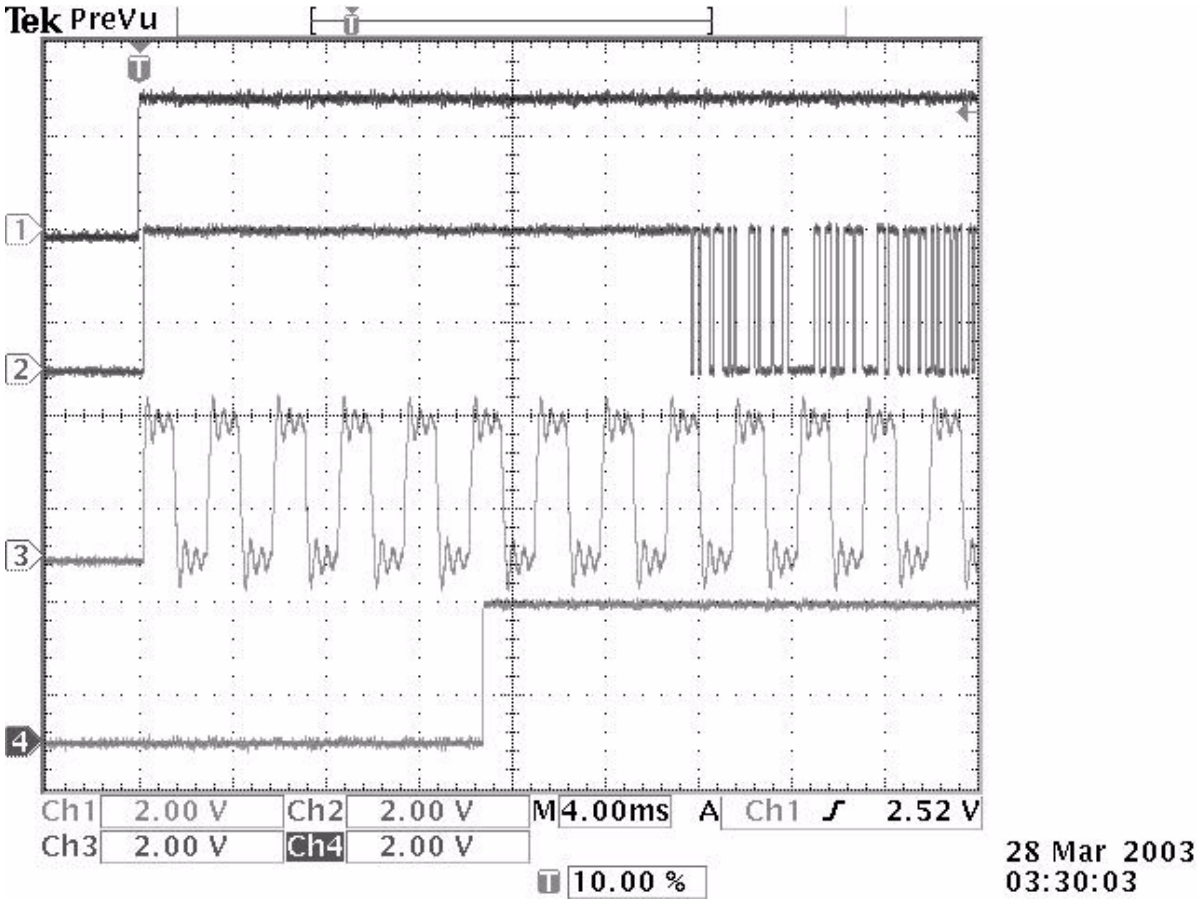
Figure 14: SIM Answer To Reset waveform



Ch1: VSIM

Ch2: I/O

Ch3: Clock

Ch4: Reset

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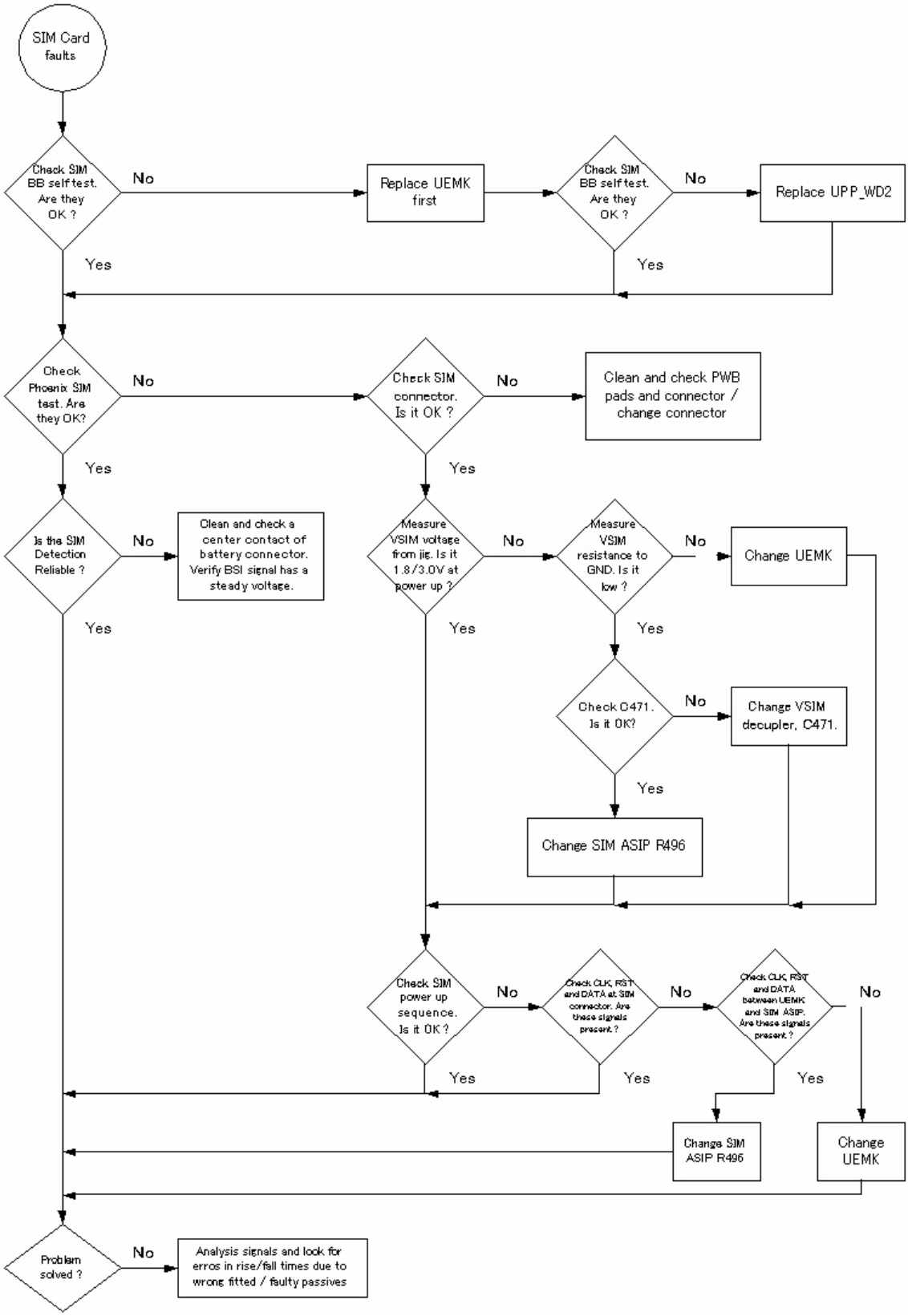
“Insert SIM Card” in device display although card is inserted

Figure 15: Insert SIM Card troubleshooting


SIM Card faults
Check SIM BB self test. Are they OK ?
No
Replace UEMK first
Check SIM BB self test. Are they OK ?
No
Replace UPP_WD2
Yes
Yes
Check Phoenix SIM test. Are they OK?
No
Check SIM connector. Is it OK ?
No
Clean and check PWB pads and connector / change connector
Yes
Yes
Is the SIM Detection Reliable ?
No
Clean and check a center contact of battery connector. Verify BSI signal has a steady voltage.
Measure VSIM voltage from jig. Is it 1.8/3.0V at power up ?
No
Measure VSIM resistance to GND. Is it low ?
No
Change UEMK
Yes
Yes
Yes
Check C471. Is it OK?
No
Change VSIM decupler, C471.
Yes
Change SIM ASIP R496
Check SIM power up sequence. Is it OK ?
No
Check CLK, RST and DATA at SIM connector. Are these signals present ?
No
Check CLK, RST and DATA between UEMK and SIM ASIP. Are these signals present ?
No
Yes
Yes
Yes
Change SIM ASIP R496
Change UEMK
Problem solved ?
No
Analysis signals and look for erros in rise/fall times due to wrong fitted / faulty passives

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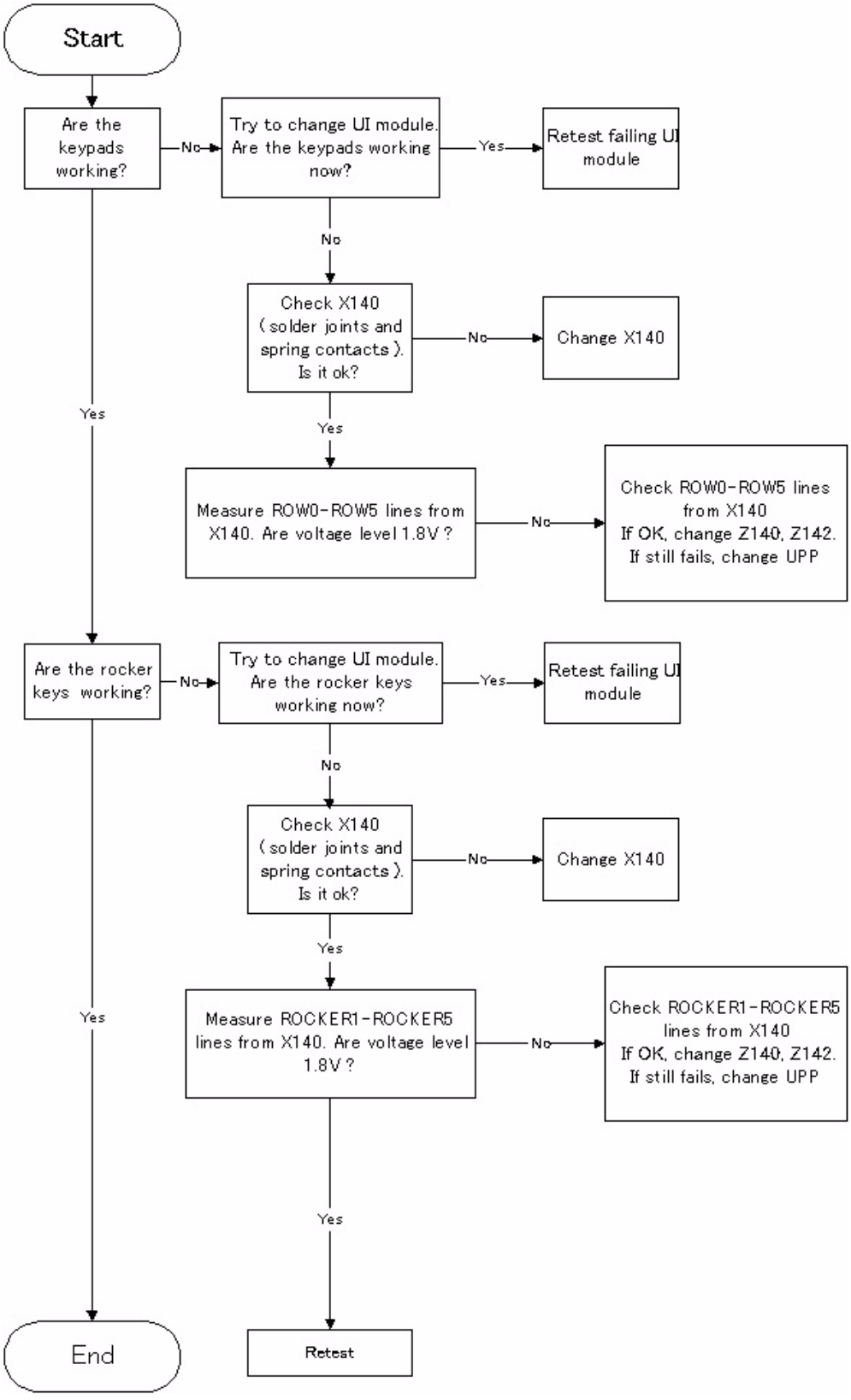
Keypad Interface Fault

Figure 16: Keypad troubleshooting


Start
Are the keypads working?
No
Try to change UI module. Are the keypads working now?
Yes
Retest failing UI module
No
Check X140 (solder joints and spring contacts). Is it ok?
No
Change X140
Yes
Measure ROW0-ROW5 lines from X140. Are voltage level 1.8V ?
No
Check ROW0-ROW5 lines from X140 If OK, change Z140, Z142. If still fails, change UPP
Yes
Are the rocker keys working?
No
Try to change UI module. Are the rocker keys working now?
Yes
Retest failing UI module
No
Check X140 (solder joints and spring contacts). Is it ok?
No
Change X140
Yes
Measure ROCKER1-ROCKER5 lines from X140. Are voltage level 1.8V ?
No
Check ROCKER1-ROCKER5 lines from X140 If OK, change Z140, Z142. If still fails, change UPP
Yes
Yes
End
Retest

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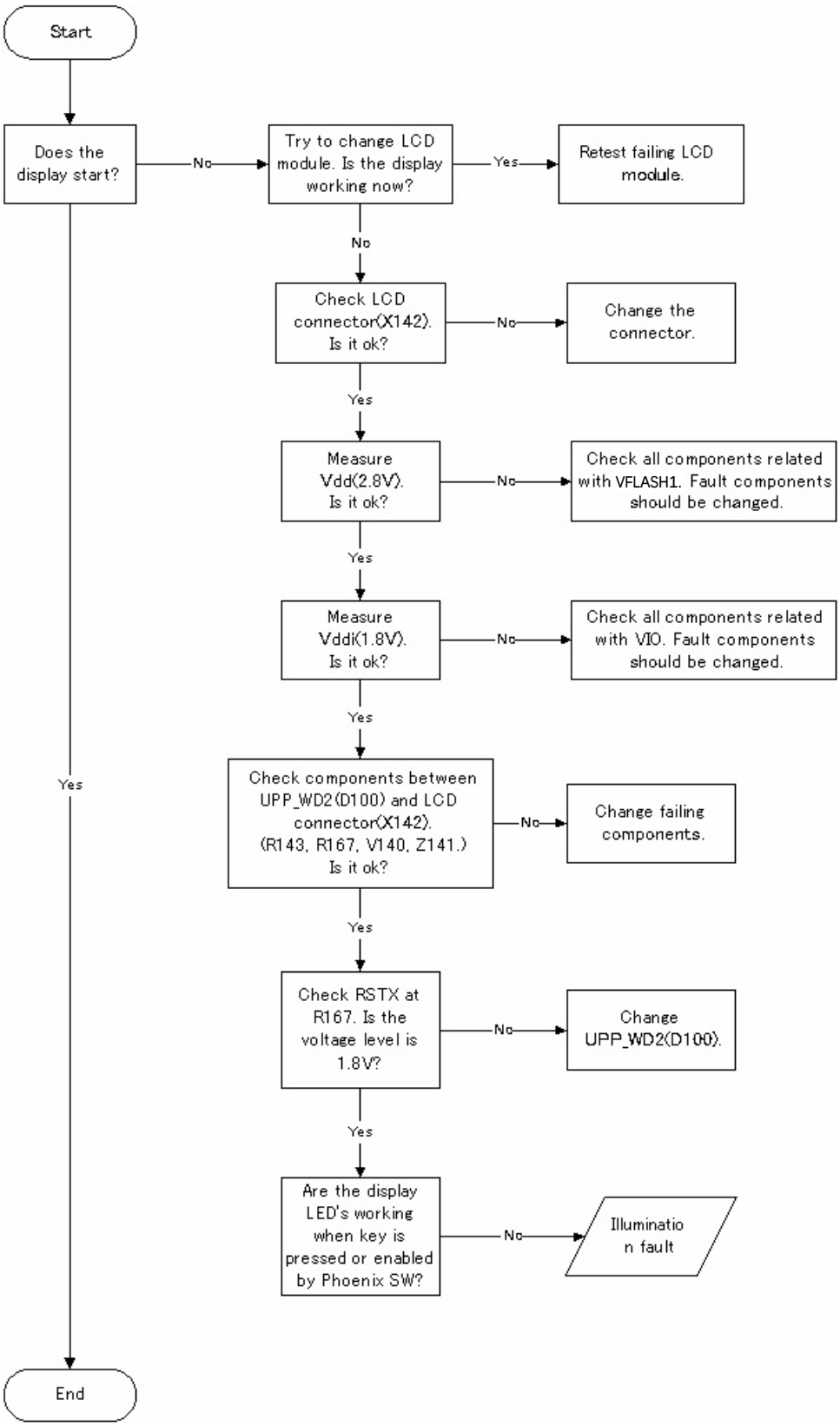
Display Fault

Figure 17: Display troubleshooting



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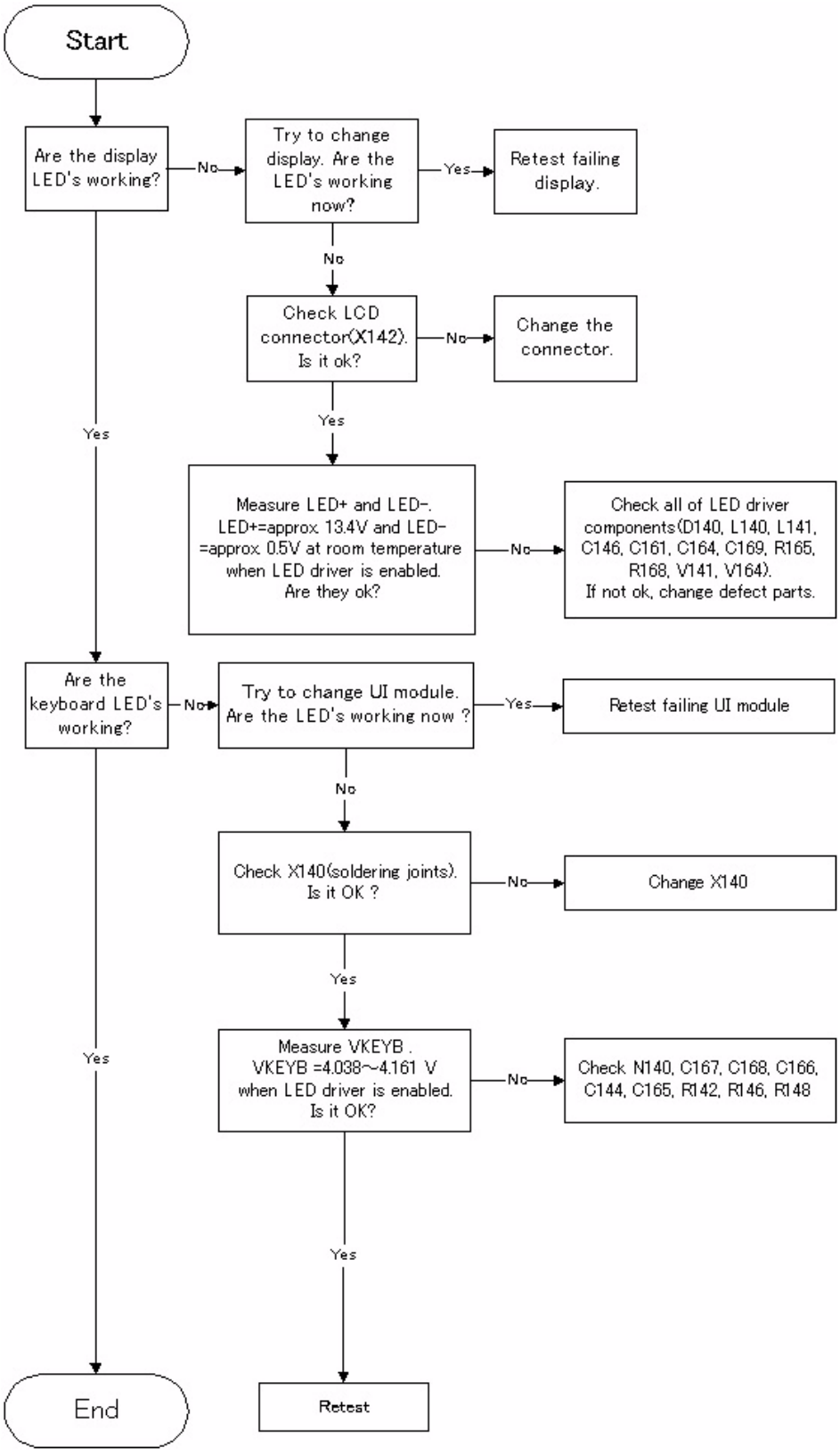
Illumination Fault (Display/Keyboard backlight)

Figure 18: Illumination troubleshooting


Start
Are the display LED's working?
No
Try to change display. Are the LED's working now?
Yes
Retest failing display.
No
Check LCD connector(X142). Is it ok?
No
Change the connector.
Yes
Yes
Measure LED+ and LED-. LED+=approx 13.4V and LED-=approx 0.5V at room temperature when LED driver is enabled. Are they ok?
No
Check all of LED driver components(D140, L140, L141, C146, C161, C164, C169, R165, R168, V141, V164). If not ok, change defect parts.
Are the keyboard LED's working?
No
Try to change UI module. Are the LED's working now ?
Yes
Retest failing UI module
No
Check X140(soldering joints). Is it OK ?
No
Change X140
Yes
Yes
Measure VKEYB . VKEYB =4.038~4.161 V when LED driver is enabled. Is it OK?
No
Check N140, C167, C168, C166, C144, C165, R142, R146, R148
Yes
End
Retest

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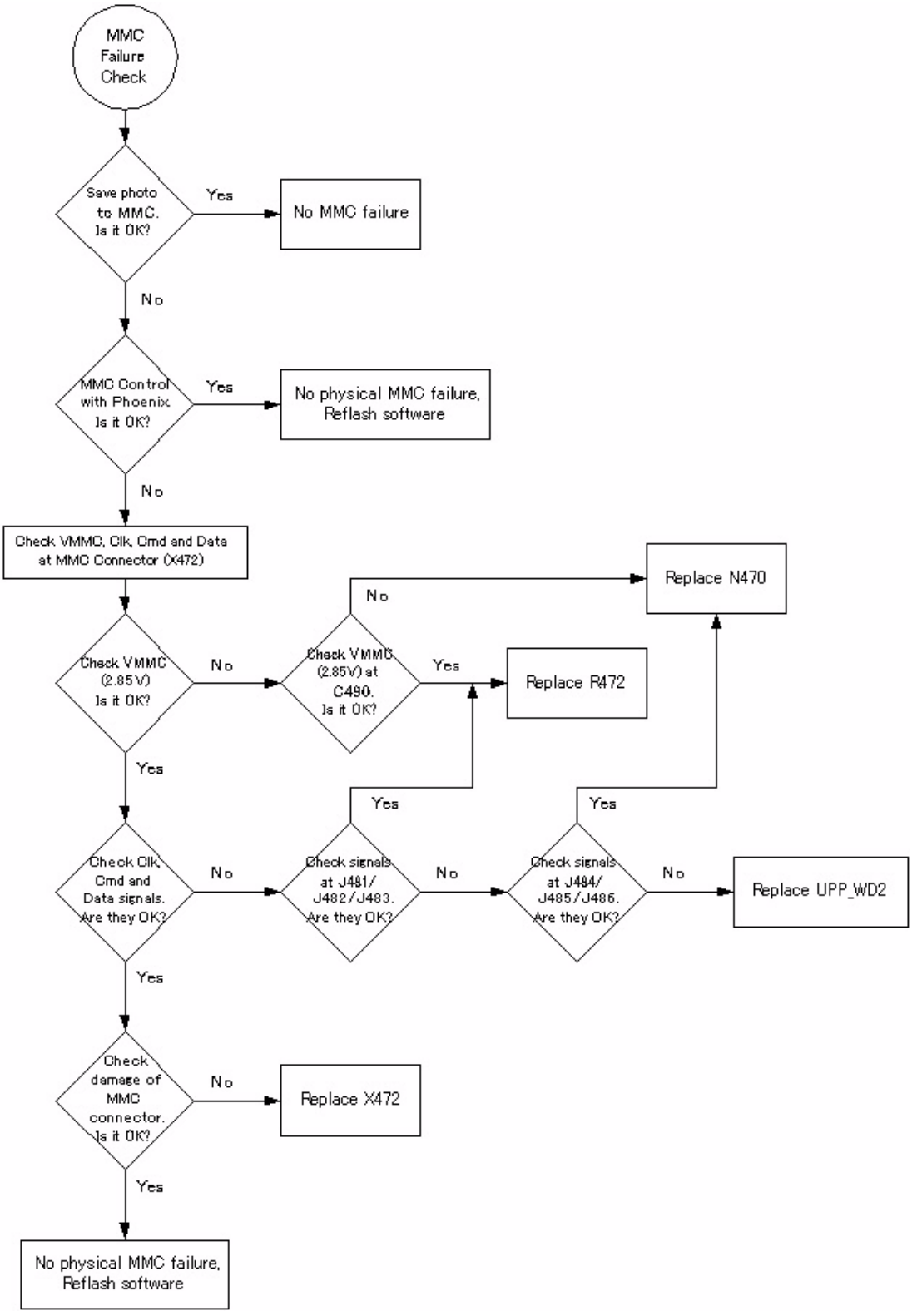
MMC Interface Fault

Use with known working MMC to save photo test.

Figure 19: MMC troubleshooting



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Audio troubleshooting

Microphone

Figure 20: Internal MIC troubleshooting

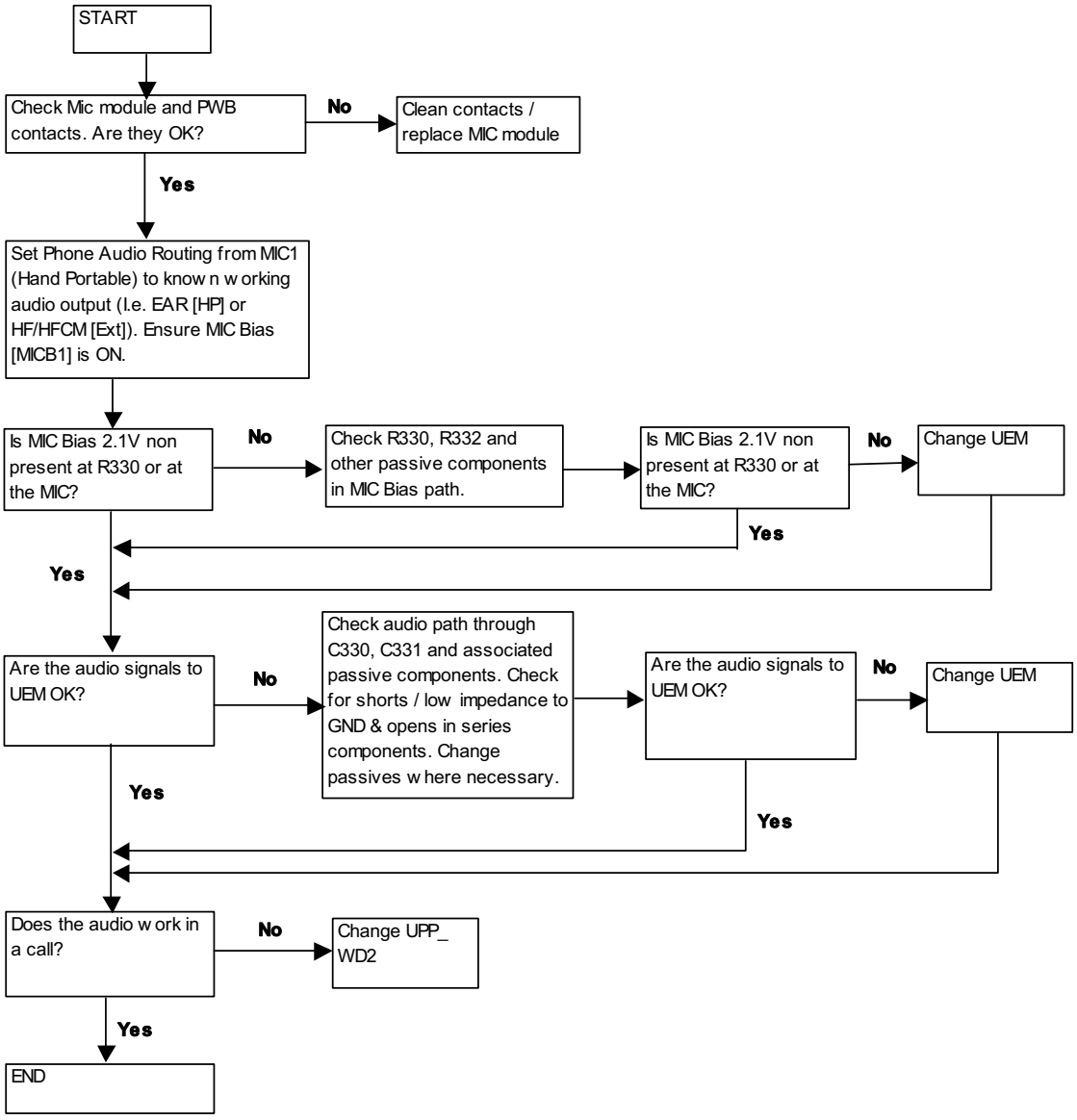
START
Check Mic module and PWB contacts. Are they OK?
No
Clean contacts / replace MIC module
Yes
Set Phone Audio Routing from MIC1 (Hand Portable) to know n w orking audio output (I.e. EAR [HP] or HF/HFCM [Ext]). Ensure MIC Bias [MICB1] is ON.
Is MIC Bias 2.1V non present at R330 or at the MIC?
No
Check R330, R332 and other passive components in MIC Bias path.
Is MIC Bias 2.1V non present at R330 or at the MIC?
No
Change UEM
Yes
Yes
Are the audio signals to UEM OK?
No
Check audio path through C330, C331 and associated passive components. Check for shorts / low impedance to GND & opens in series components. Change passives w here necessary.
Are the audio signals to UEM OK?
No
Change UEM
Yes
Yes
Does the audio w ork in a call?
No
Change UPP_ WD2
Yes
END

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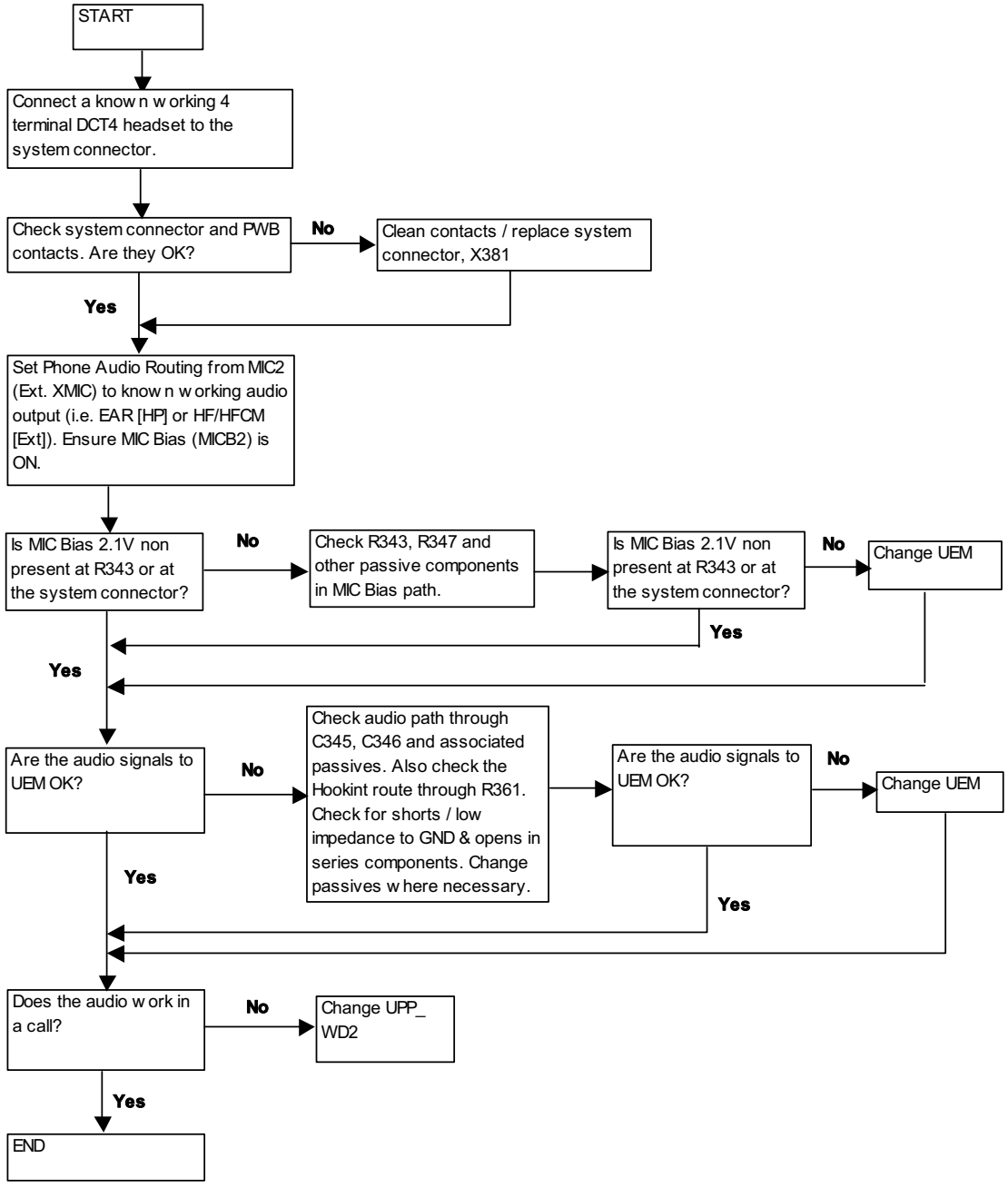
Figure 21: External MIC troubleshooting


START
Connect a known working 4 terminal DCT4 headset to the system connector.
Check system connector and PWB contacts. Are they OK?
No
Clean contacts / replace system connector, X381
Yes
Set Phone Audio Routing from MIC2 (Ext. XMIC) to known working audio output (i.e. EAR [HP] or HF/HFCM [Ext]). Ensure MIC Bias (MICB2) is ON.
Is MIC Bias 2.1V non present at R343 or at the system connector?
No
Check R343, R347 and other passive components in MIC Bias path.
Is MIC Bias 2.1V non present at R343 or at the system connector?
No
Change UEM
Yes
Yes
Are the audio signals to UEM OK?
No
Check audio path through C345, C346 and associated passives. Also check the Hookint route through R361. Check for shorts / low impedance to GND & opens in series components. Change passives where necessary.
Are the audio signals to UEM OK?
No
Change UEM
Yes
Yes
Does the audio work in a call?
No
Change UPP_WD2
Yes
END

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Earpiece

Check that holes are not coated.

Figure 22: Internal Earpiece troubleshooting

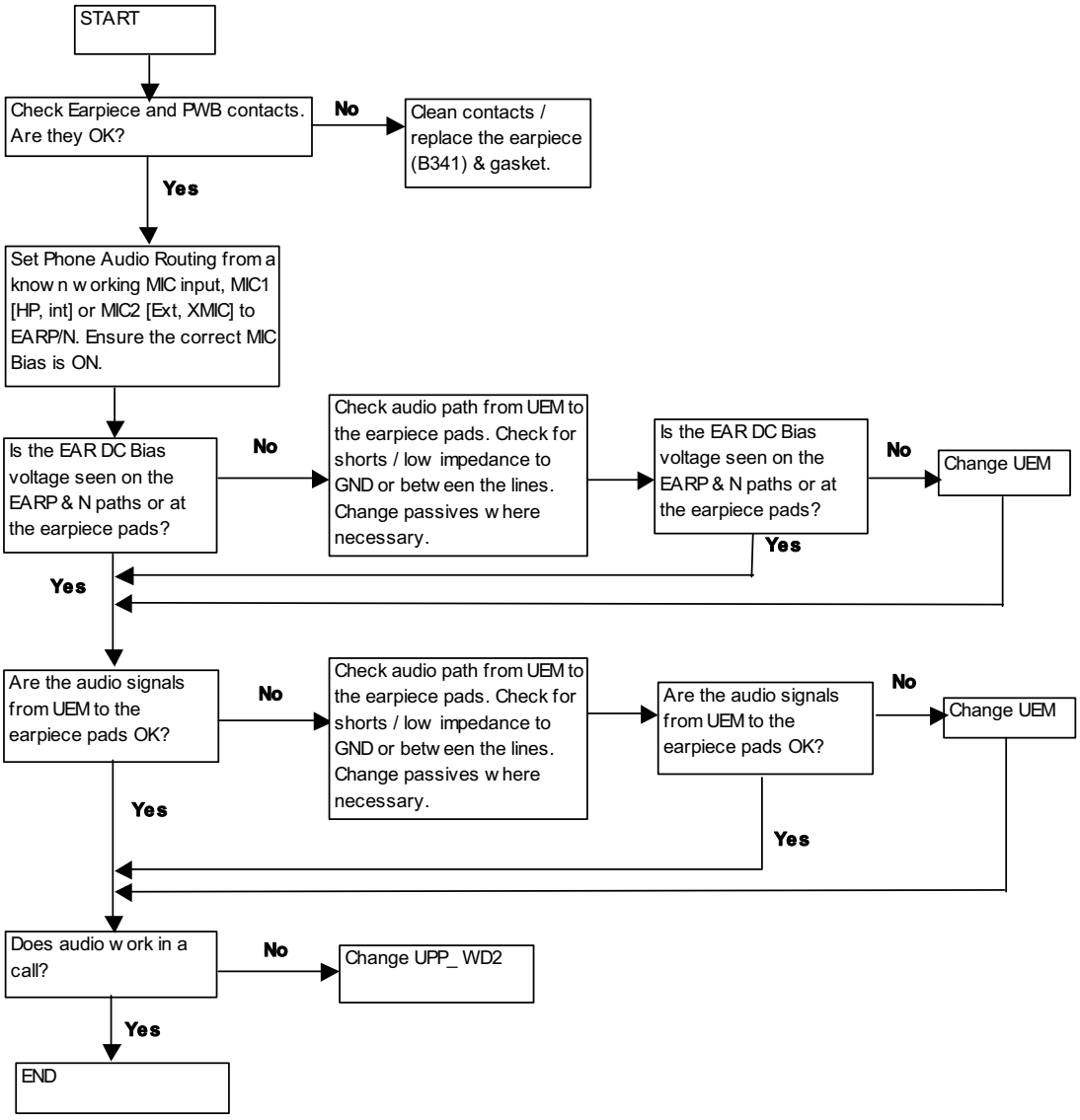
START
Check Earpiece and PWB contacts. Are they OK?
No
Clean contacts / replace the earpiece (B341) & gasket.
Yes
Set Phone Audio Routing from a know n w orking MIC input, MIC1 [HP, int] or MIC2 [Ext, XMIC] to EARP/N. Ensure the correct MIC Bias is ON.
Is the EAR DC Bias voltage seen on the EARP & N paths or at the earpiece pads?
No
Check audio path from UEM to the earpiece pads. Check for shorts / low impedance to GND or betw een the lines. Change passives w here necessary.
Is the EAR DC Bias voltage seen on the EARP & N paths or at the earpiece pads?
No
Change UEM
Yes
Yes
Are the audio signals from UEM to the earpiece pads OK?
No
Check audio path from UEM to the earpiece pads. Check for shorts / low impedance to GND or betw een the lines. Change passives w here necessary.
Are the audio signals from UEM to the earpiece pads OK?
No
Change UEM
Yes
Yes
Does audio w ork in a call?
No
Change UPP_ WD2
Yes
END

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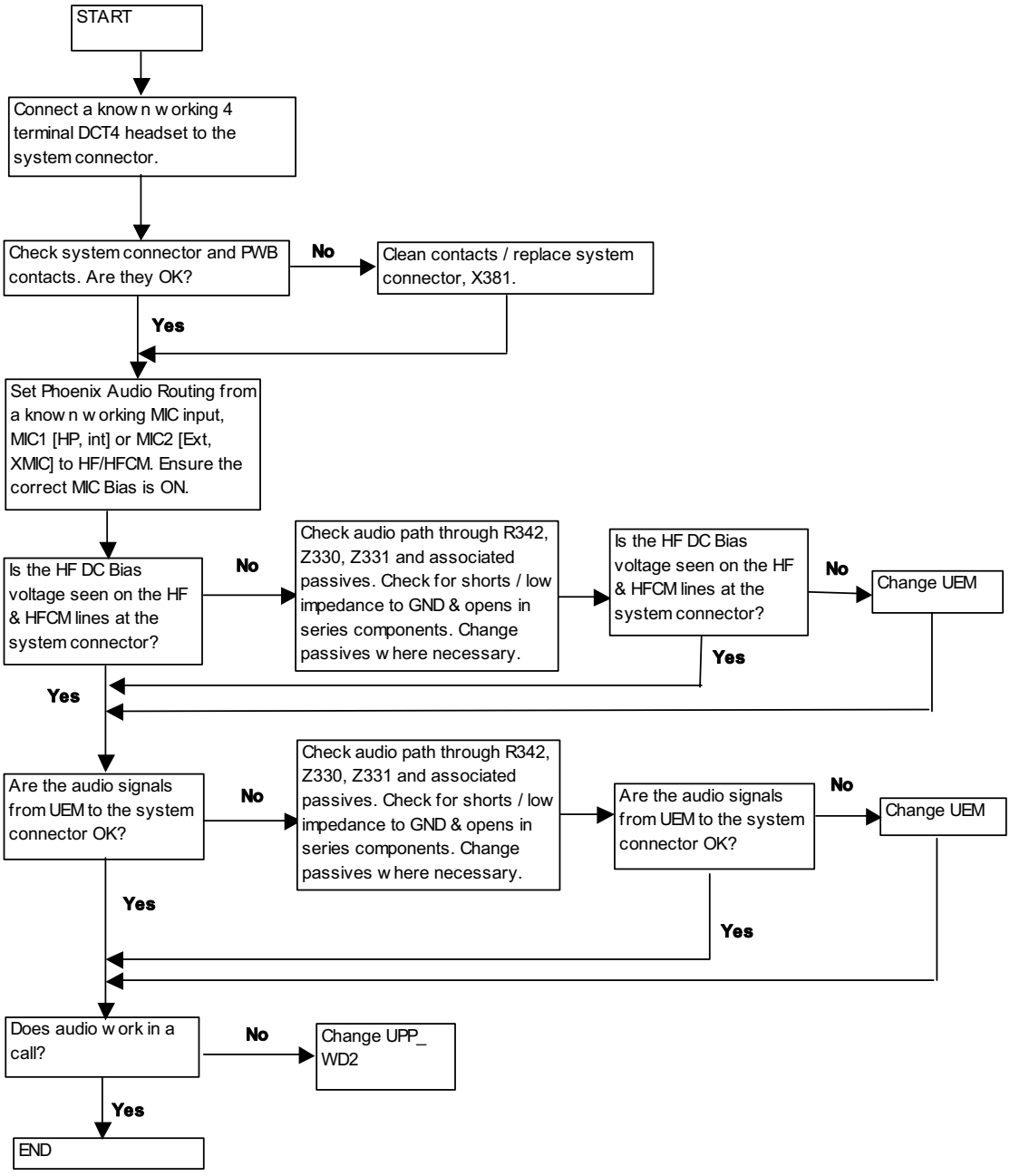
Figure 23: External Earpiece troubleshooting


START
Connect a know n w orking 4 terminal DCT4 headset to the system connector.
Check system connector and PWB contacts. Are they OK?
No
Clean contacts / replace system connector, X381.
Yes
Set Phoenix Audio Routing from a know n w orking MIC input, MIC1 [HP, int] or MIC2 [Ext, XMIC] to HF/HFCM. Ensure the correct MIC Bias is ON.
Is the HF DC Bias voltage seen on the HF & HFCM lines at the system connector?
No
Check audio path through R342, Z330, Z331 and associated passives. Check for shorts / low impedance to GND & opens in series components. Change passives w here necessary.
Is the HF DC Bias voltage seen on the HF & HFCM lines at the system connector?
No
Change UEM
Yes
Yes
Are the audio signals from UEM to the system connector OK?
No
Check audio path through R342, Z330, Z331 and associated passives. Check for shorts / low impedance to GND & opens in series components. Change passives w here necessary.
Are the audio signals from UEM to the system connector OK?
No
Change UEM
Yes
Yes
Does audio w ork in a call?
No
Change UPP_ WD2
Yes
END

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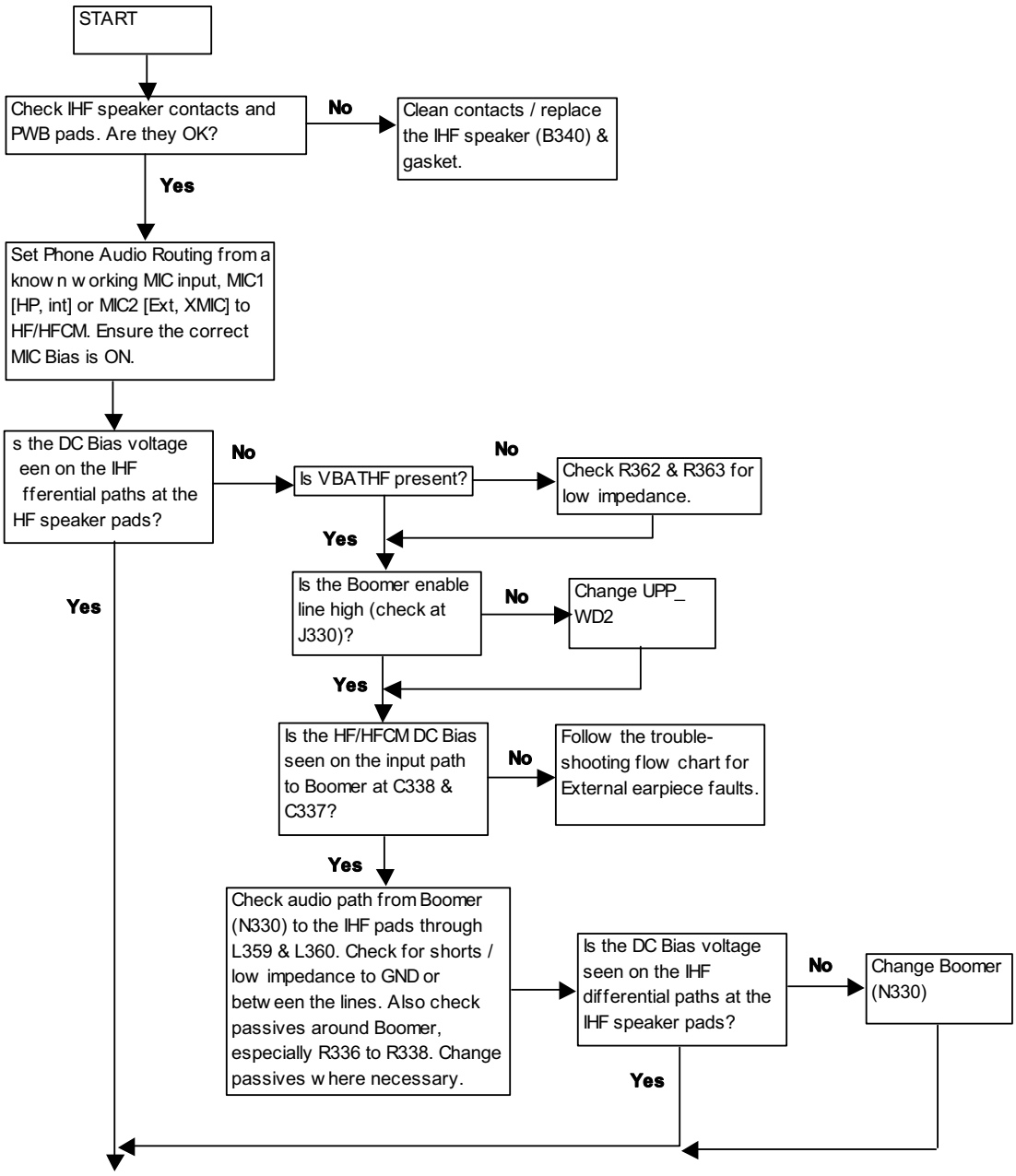
IHF

Figure 24: IHF troubleshooting


START
Check IHF speaker contacts and PWB pads. Are they OK?
No
Clean contacts / replace the IHF speaker (B340) & gasket.
Yes
Set Phone Audio Routing from a know n w orking MIC input, MIC1 [HP, int] or MIC2 [Ext, XMIC] to HF/HFCM. Ensure the correct MIC Bias is ON.
s the DC Bias voltage een on the IHF fferential paths at the HF speaker pads?
No
Is VBATHF present?
No
Check R362 & R363 for low impedance.
Yes
Yes
Is the Boomer enable line high (check at J330)?
No
Change UPP_ WD2
Yes
Is the HF/HFCM DC Bias seen on the input path to Boomer at C338 & C337?
No
Follow the trouble-shooting flow chart for External earpiece faults.
Yes
Check audio path from Boomer (N330) to the IHF pads through L359 & L360. Check for shorts / low impedance to GND or betw een the lines. Also check passives around Boomer, especially R336 to R338. Change passives w here necessary.
Is the DC Bias voltage seen on the IHF differential paths at the IHF speaker pads?
No
Change Boomer (N330)
Yes

See the following flow chart

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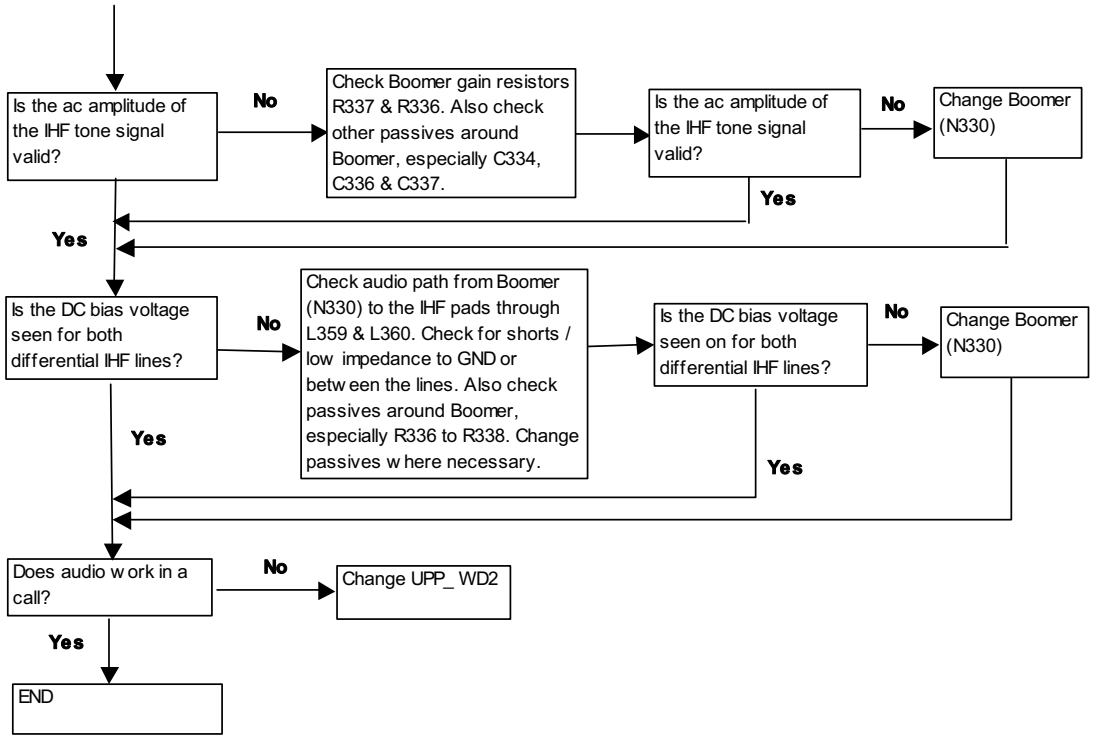
See the previous flow chart


Is the ac amplitude of the IHF tone signal valid?
No
Check Boomer gain resistors R337 & R336. Also check other passives around Boomer, especially C334, C336 & C337.
Is the ac amplitude of the IHF tone signal valid?
No
Change Boomer (N330)
Yes
Yes
Is the DC bias voltage seen for both differential IHF lines?
No
Check audio path from Boomer (N330) to the IHF pads through L359 & L360. Check for shorts / low impedance to GND or between the lines. Also check passives around Boomer, especially R336 to R338. Change passives where necessary.
Is the DC bias voltage seen on for both differential IHF lines?
No
Change Boomer (N330)
Yes
Yes
Does audio work in a call?
No
Change UPP_ WD2
Yes
END

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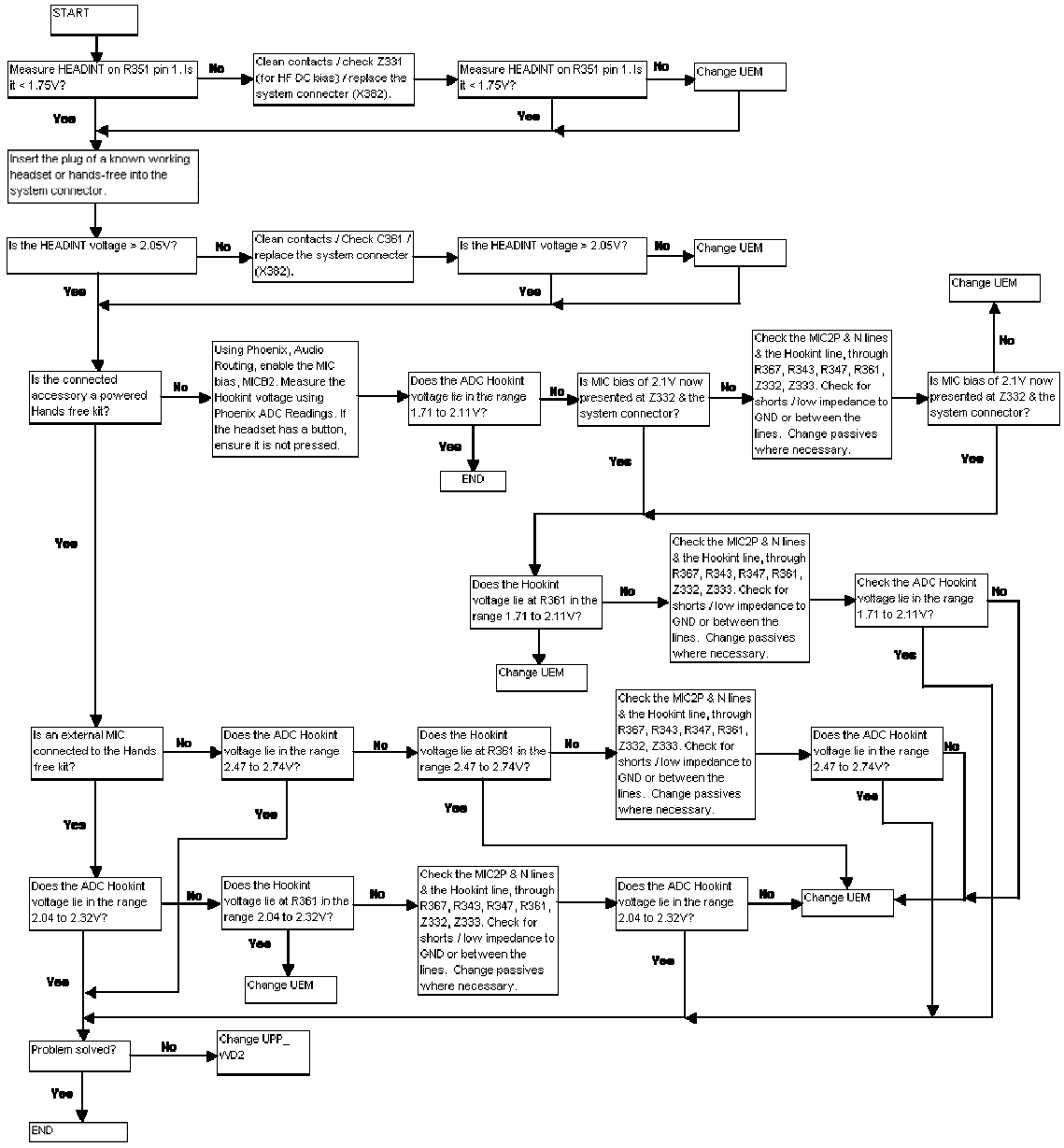
Accessory detection troubleshooting

Figure 25: Accessory detection troubleshooting


START
Measure HEADINT on R351 pin 1. Is it < 1.75V?
No
Clean contacts / check Z331 (for HF DC bias) / replace the system connecter (X382).
Measure HEADINT on R351 pin 1. Is it < 1.75V?
No
Change UEM
Yes
Yes
Insert the plug of a known working headset or hands-free into the system connector.
Is the HEADINT voltage > 2.05V?
No
Clean contacts / Check C361 / replace the system connecter (X382).
Is the HEADINT voltage > 2.05V?
No
Change UEM
Yes
Yes
Change UEM
No
Is the connected accessory a powered Hands free kit?
No
Using Phoenix, Audio Routing, enable the MIC bias, MICB2. Measure the Hookint voltage using Phoenix ADC Readings. If the headset has a button, ensure it is not pressed.
Does the ADC Hookint voltage lie in the range 1.71 to 2.11V?
No
Is MIC bias of 2.1V now presented at Z332 & the system connector?
No
Check the MIC2P & N lines & the Hookint line, through R367, R343, R347, R361, Z332, Z333. Check for shorts / low impedance to GND or between the lines. Change passives where necessary.
Is MIC bias of 2.1V now presented at Z332 & the system connector?
Yes
Yes
END
Yes
Yes
Does the Hookint voltage lie at R361 in the range 1.71 to 2.11V?
No
Check the MIC2P & N lines & the Hookint line, through R367, R343, R347, R361, Z332, Z333. Check for shorts / low impedance to GND or between the lines. Change passives where necessary.
Check the ADC Hookint voltage lie in the range 1.71 to 2.11V?
No
Yes
Change UEM
Is an external MIC connected to the Hands free kit?
No
Does the ADC Hookint voltage lie in the range 2.47 to 2.74V?
No
Does the Hookint voltage lie at R361 in the range 2.47 to 2.74V?
No
Check the MIC2P & N lines & the Hookint line, through R367, R343, R347, R361, Z332, Z333. Check for shorts / low impedance to GND or between the lines. Change passives where necessary.
Does the ADC Hookint voltage lie in the range 2.47 to 2.74V?
No
Yes
Yes
Yes
Yes
Does the ADC Hookint voltage lie in the range 2.04 to 2.32V?
No
Does the Hookint voltage lie at R361 in the range 2.04 to 2.32V?
No
Check the MIC2P & N lines & the Hookint line, through R367, R343, R347, R361, Z332, Z333. Check for shorts / low impedance to GND or between the lines. Change passives where necessary.
Does the ADC Hookint voltage lie in the range 2.04 to 2.32V?
No
Change UEM
Yes
Yes
Change UEM
Yes
Problem solved?
No
Change UPP_WD2
Yes
END

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Camera Module Troubleshooting

A fault associated to camera operation can be roughly categorized to three subgroups:

1 Camera is not functional at all, no image can be obtained.

2 Images can be taken but there is nothing recognizable in them.

3 Images can be taken and they are recognizable but for some reason the quality of images is seriously degraded.

Type 1 and 2 faults are most often similar to what traditionally has been found in any electronic devices. Type 3 faults are new to NMP and maybe the most challenging to find and verify.

The image quality is very hard to measure quantitatively, and even comparative measurements are difficult (comparing two images) if the difference is small. Especially, if the user is not satisfied with his/her devices' image quality, and tells e.g. that the images are not sharp, it is very difficult to test the device and get an exact figure which then would tell if the device is OK or not.

Most often, subjective evaluation has to be used for finding out if a certain property of the camera is acceptable or not. Some training and a correctly operating reference device maybe needed in order to detect what actually is wrong, or is there anything wrong at all. It is easy for the user to take bad looking images in bad conditions; thus the camera operation has to be checked always in constant conditions (lighting, temperature) or by using a second, known to be good device as a reference. Experience significantly helps in analysing image quality.

Terms

Dynamic range: camera's ability to capture details in dark and bright areas of the scene simultaneously.

Exposure time: camera modules use silicon sensor to collect light and for forming an image. The imaging process roughly corresponds to traditional film photography, in which exposure time means the time during which the film is exposed to the light coming through optics. Increasing the time will allow for more light hitting the film and thus results in brighter image. The operation principle is exactly the same with silicon sensor, but the shutter functionality is handled electronically i.e. there is no mechanical moving parts like in film cameras.

Flicker: A phenomena, which is caused by pulsating in scene lighting, typically appearing as wide horizontal stripes in image.

Noise: Variation of response between pixels with the same level of input illumination. See e.g. Figure 29: Noisy image taken in +70 deg, for an example of a noisy image.

Image taking condition effect on image quality

This chapter lists some of the factors, which may cause poor image quality if not taken into account, and thus result in complaints from customers.

Several issues affect the image quality and will need to be taken into account when shooting pictures. The listed items are normal to camera operation:

Distance to target:
The lens in the module is specified to operate satisfactorily from 30 cm to infinite distance of

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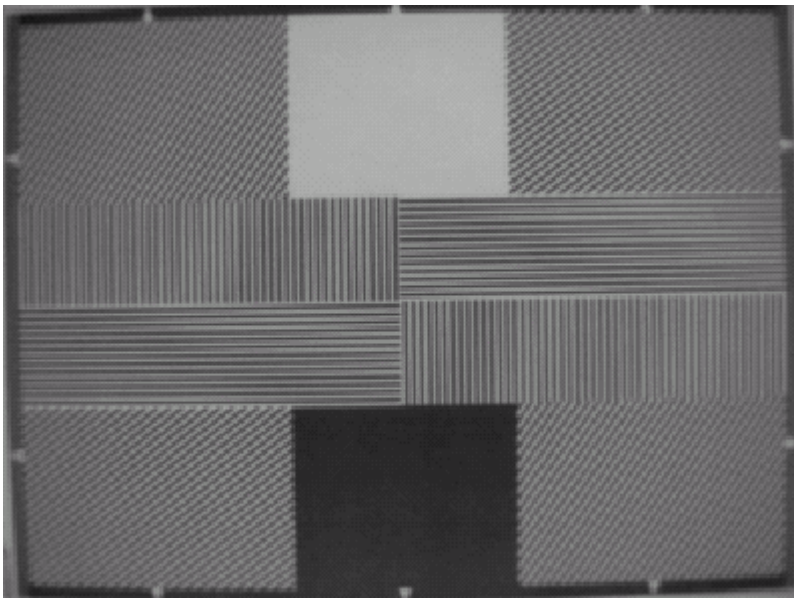
scene objects. In practice, the operation is such that close objects may be noticed to get more blurred when the distance to them is shortened from 40 cm. Lack of sharpness will be first visible in full resolution (VGA) images. If observing just the viewfinder, even very close objects may seem to appear sharp.

Sharpness of picture edges:
Lens performance degrades in image edges, and generally the image is sharpest in centre part. This applies particularly to distant objects (> 1 meter).

See below:

Figure 26: Sharpness of picture is worse in edge than in centre



Geometrical distortion:
The camera lens will cause some amount of so called barrel distortion in images. In practice, this appears as bending of straight objects in edges of the image.

See the following figure. Note the geometrical barrel distortion in background, for example (wall in the background).

Amount of light available:
In dim condition camera runs out of sensitivity. Exposure time is long (especially in night mode) and the risk of getting shaken images grows. Image noise level grows. The maximum exposure time in night mode is approximately ¼ seconds, so images need to be taken with extreme care when the amount of light reflected from the target is low.

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Figure 27: Shaking hands caused blurring of this image. Note the geometrical barrel distortion in background

Movement in bright light:
If pictures of moving objects are taken or if the device is used in a moving car, object 'skewing' or 'tilting' will occur. This phenomena is fundamental to most CMOS camera types and normal, and can not be helped. Movement of camera or object will usually cause blurring indoors or in dim lighting conditions due to long exposure time.

Figure 28: Near objects in image get skewed when shooting from a moving car

Temperature:
High temperatures inside the mobile phone will cause more noise to appear in images, e.g. in +70 degree of Celsius the noise level may be very high, and it further grows if the conditions are dim. This is also normal to camera operation. (See the following figure.)

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Figure 29: Noisy image taken in +70deg

Display:
If the display contrast is set too dark, the image quality degrades quite much: the images may be very dark, naturally depending on the setting. This flaw is easily cured by setting the display contrast to correct value.

Basic rules of photography, especially when shooting against light:
Electronic image sensors typically have much lower dynamic range than films. In practice this means that when taking a picture indoors, e.g. having a window behind object, will produce poor results.

Figure 30: Image which has been taken “against the light”. The actual object (a squirrel) can’t be seen well

Flicker:
In some rare occasions a very bright fluorescent light may cause flicker to be seen in the view-finder image.

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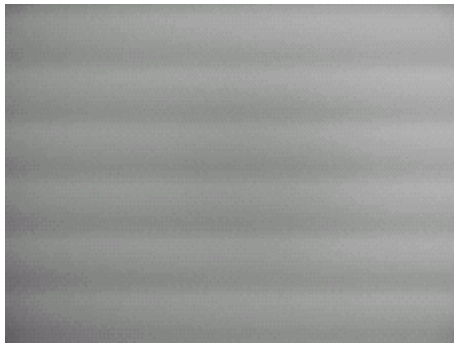
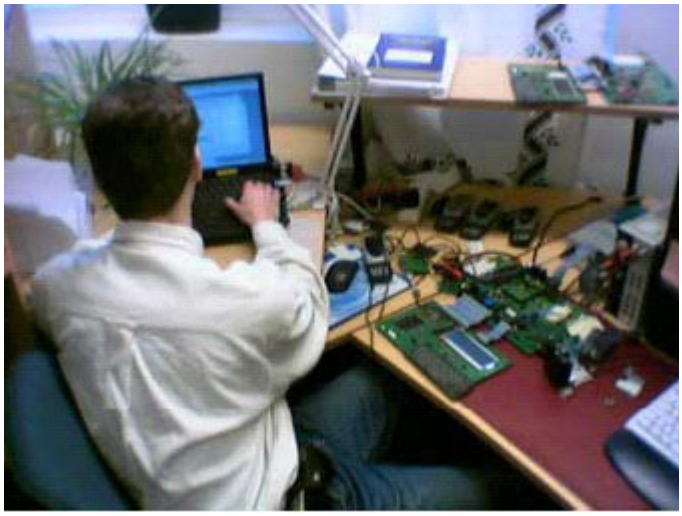
Figure 31: Flicker in image of white uniform object illuminated by strong fluorescent light



Bright light outside of image view:
Especially sun causes clearly visible ‘halo’ effects and poor contrast in images. This happens due to unwanted reflections inside camera optics.

Figure 32: A lens reflection effect caused by sun shining above the scene

Figure 33: A good quality picture taken indoors



Note: The camera module as a component is not a repairable part i.e. components in the module may not be changed. Cleaning dust from the front face is the only allowable operation.

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Image quality analysis

Possible faults in image quality

When checking for possible errors in camera functionality, knowing what error is suspected will significantly help the testing by narrowing down the amount of test cases. The following types of image quality problems may be expected to appear (in order of appearance probability):

- Dust (black spots)
- Lack of sharpness
- Bit errors

In addition, there are many other kinds of possibilities for getting bad image quality, but those are ruled out from the scope of this document since probability of their appearance is going to be minimized by production testing.

Testing for dust

For detecting this kind of problems, take an image of uniform white surface and analyse it in full resolution; search carefully – finding these defects is not always easy.

Effects of dust in optical path are an example of image containing easily detectable dust problems.

Black spots in image are caused by dirt particles trapped into the optical system: clearly visible and sharp edged black dots in the image are typically dust particles on the image sensor. These spots are searched for in the manufacturing phase, but it is possible that the lens holder cavity contains a particle, which may move onto the image sensor active surface, e.g. when the phone is dropped. Thus, it is also possible that the problem will disappear before the phone is brought to service. The camera should be replaced if it has been in some phase verified that the problem has been present.

If dust particles are located on the infrared filter surface on either side, they are much harder to locate because they will be out of focus, and appear in the image as large, greyish and fading-edge ‘blobs’. Sometimes they will be very hard to find, and thus the user probably will not notice them at all since they do no harm. But it is possible that a larger particle disturbs the user, causing the need for service.

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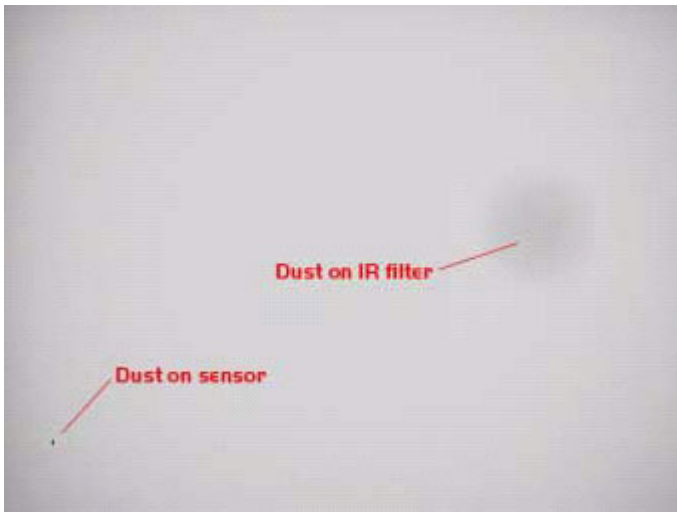
Figure 34: Effects of dust in optical path



If large dust particles get trapped on top of the lens surface in the cavity between the camera window and lens, they will cause image blurring and poor contrast (see also item ‘sharpness’). The seal between the window and lens should prevent any particles from getting into the cavity after manufacturing phase.

If dust particles are found on the sensor or are suspected to be inside the camera module, this is classified as a manufacturing error of the module and thus the camera should be replaced. The particles inside the cavity between window and lens have most probably been trapped there in assembly phase in Nokia factory. It is of course also possible that the user has disassembled the device and caused the problem. However, in most cases it should be possible to remove the particle(s) by using compressed air. Never wipe the lens surface before trying compressed air; the possibility of damaging the lens is substantial.

Always check the image sharpness after removing dust.

Testing for sharpness

If pictures taken with some device are claimed to be blurry, there are four possible sources for the clam:

1 The user has tried to take pictures in too dark conditions and images are blurred due to handshake or movement. This is no cause to replace the camera module.

2 There is dirt between the back window and camera lens.
The back window is defective (somehow passed through window manufacturer’s inspection). The window should be changed.

3 The back window is visibly scratched, broken or dirty.

4 Camera lens is misfocused.

Quantitative analysis of sharpness is very difficult to conduct in other than optics laboratory environment. Thus subjective analysis should be used.

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If no visible defects (items 2-4) can be found, a couple of test images should be taken and checked. Generally, a well illuminated typical indoor office scene, such as the one in Figure 33: A good quality picture taken indoors, can be used as a target.

The main considerations are:

The amount of light, 300 – 600 lux (bright office lighting), is sufficient.

The scene should contain e.g. small objects for checking sharpness and distance to them should be in order of 1 – 2 meters

If possible, compare the image to another image of the same scene, taken by different device.

The taken images should be analysed on PC screen at 100% scaling simultaneously with reference image. Pay attention to the computer display settings; at least 65000 colours (16bit) have to be used. 256(8-bit) colour setting is not sufficient, and true colour (24bit, 16 million colours) or 32 bit (full colour) setting is recommended.

If there appears to be a clearly noticeable difference between the reference image and the test images, the module might have a misfocused lens. In this case, the module should be changed.

Always re-check the resolution after changing the camera. If a different module produces the same result, the fault is probably in the camera window. Check that you can see through the window when replacing the module.

Bit errors

Bit errors are defects in image caused by a data transmission error between camera and phone baseband. This type of error is expected to be rare since usually missing bits will cause a hardware failure message. Bit errors can be typically seen in images taken of any object, and they should be most visible in full VGA resolution images.

Viewfinder images may not contain the errors at all due to lower bit rate used in this mode.

A good practice is to use uniform white test target.

The errors will be clearly visible as colourful sharp dots or lines in camera VGA images.

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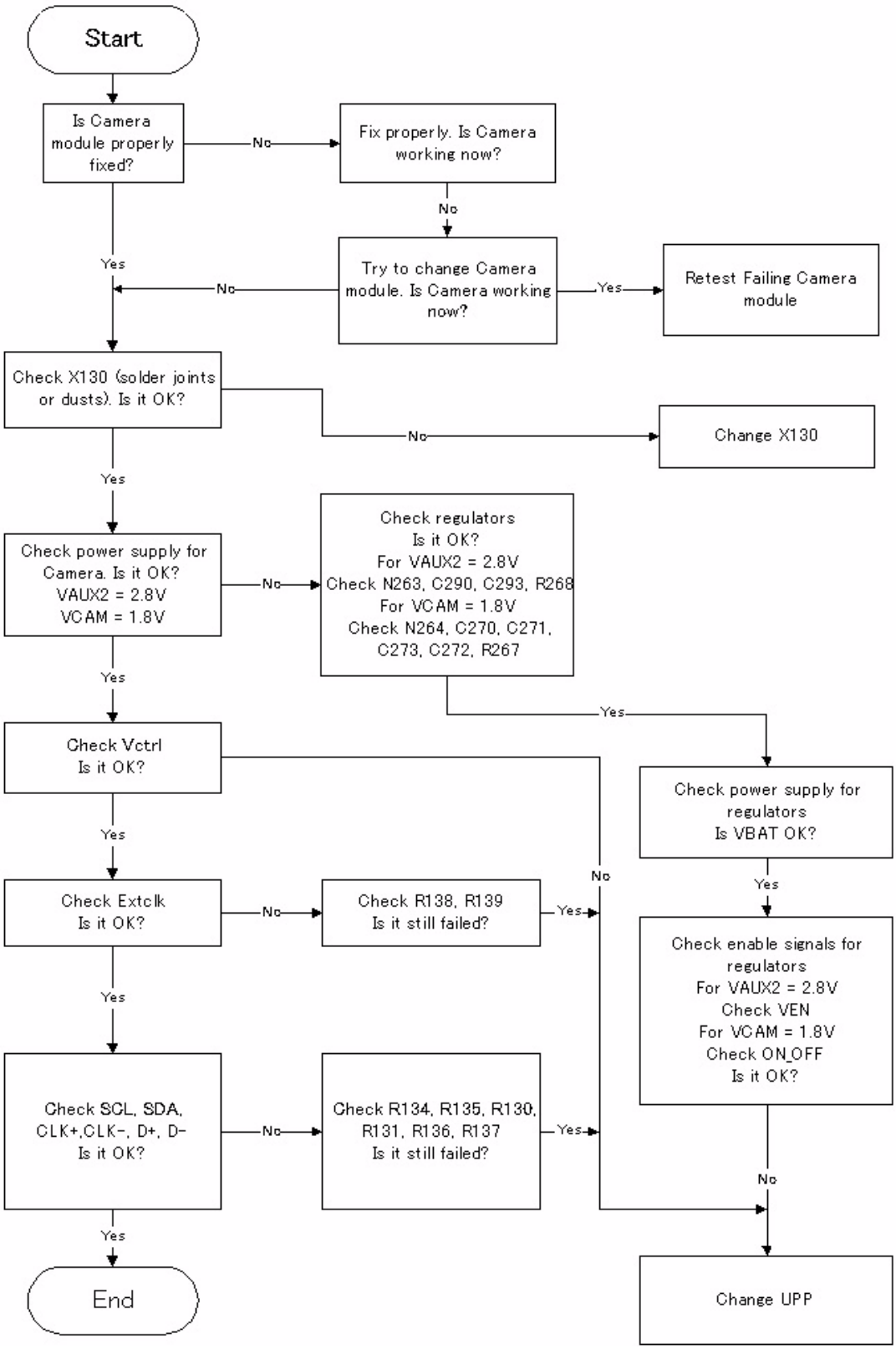
Hardware failure message

Figure 35: Hardware failure troubleshooting



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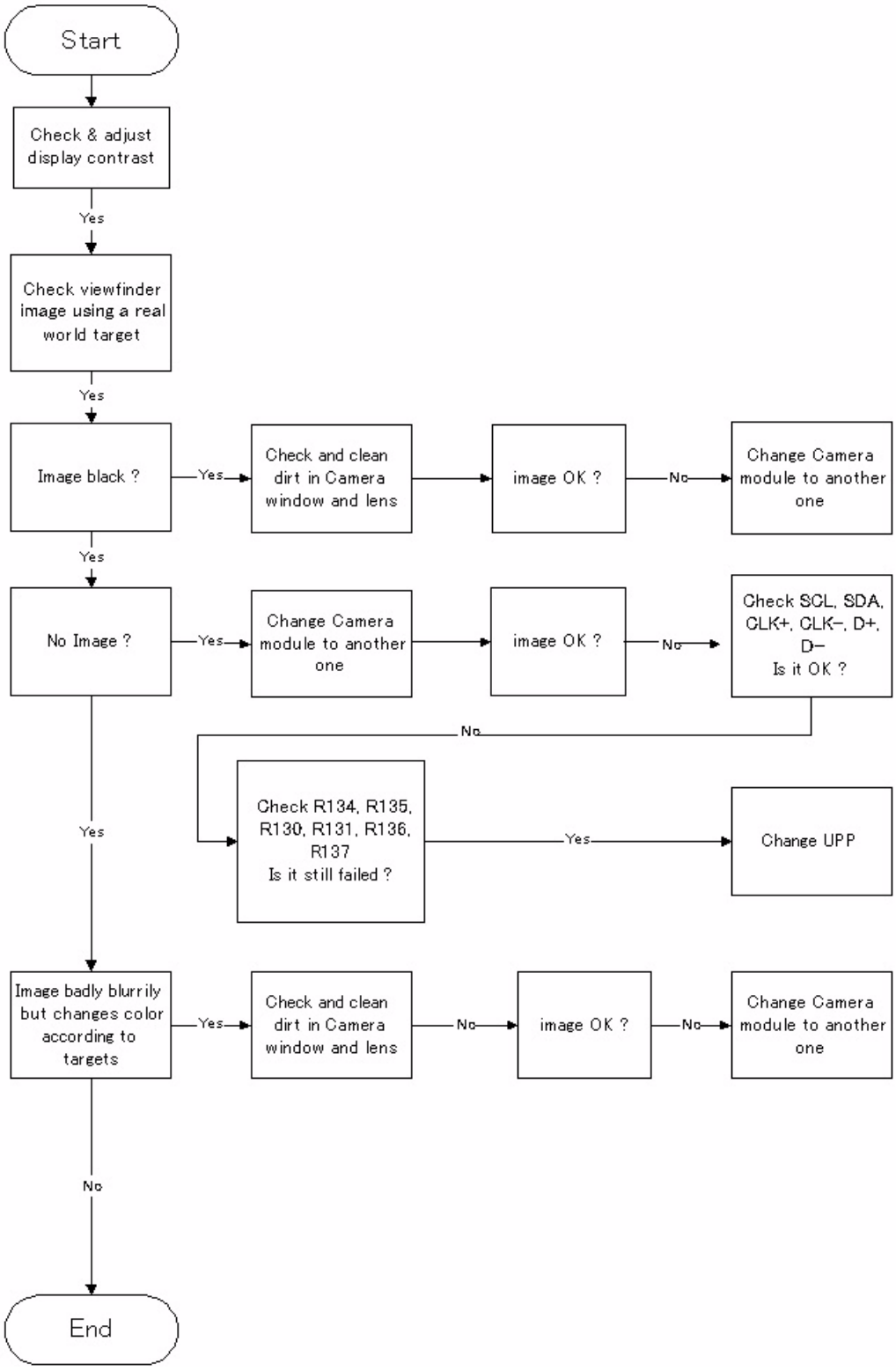
No recognizable viewfinder image

Figure 36: No recognizable viewfinder image



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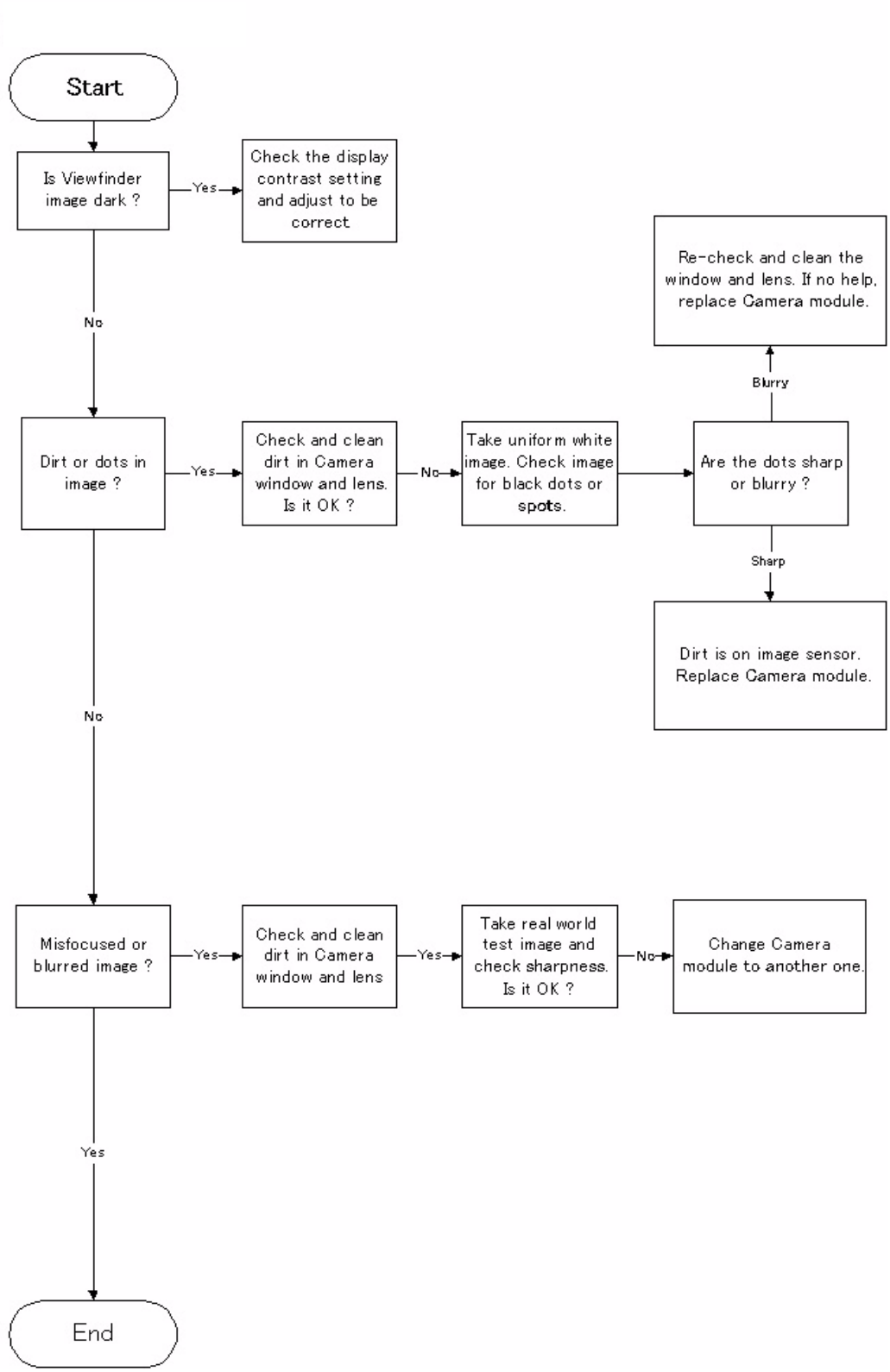
Bad image quality

Figure 37: Bad image quality troubleshooting


Start
Is Viewfinder image dark ?
Yes
Check the display contrast setting and adjust to be correct
No
Dirt or dots in image ?
Yes
Check and clean dirt in Camera window and lens. Is it OK ?
No
Take uniform white image. Check image for black dots or spots.
Are the dots sharp or blurry ?
Blurry
Re-check and clean the window and lens. If no help, replace Camera module.
Sharp
Dirt is on image sensor. Replace Camera module.
No
Misfocused or blurred image ?
Yes
Check and clean dirt in Camera window and lens
Yes
Take real world test image and check sharpness. Is it OK ?
No
Change Camera module to another one.
Yes
End

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Baseband Tuning operation

Energy management calibration

EM calibration is performed to calibrate the setting (Gain and offset) of AD converters in several channels (i.e. Battery Size, Battery voltage, Charger voltage, Charger current, Battery Current). This is to get accurate conversion result of AD converter.

Connections

The NHL-10 phone must be connected to JBV-1 (Docking station) with DA-2 (Docking station adapter).

- Connect SCB-3 (DC-DC cable) between JBV-1 and charger connector of phone for charger channel calibration.
- Supply 11-16 V DC from external power supply to JBV-1 to power up phone.

Phoenix Setup

- Start Phoenix service software.
- Select FBUS connection.
- Choose Main -> Choose product-> NHL-10.
- Choose Tuning-> Energy Management Calibration.

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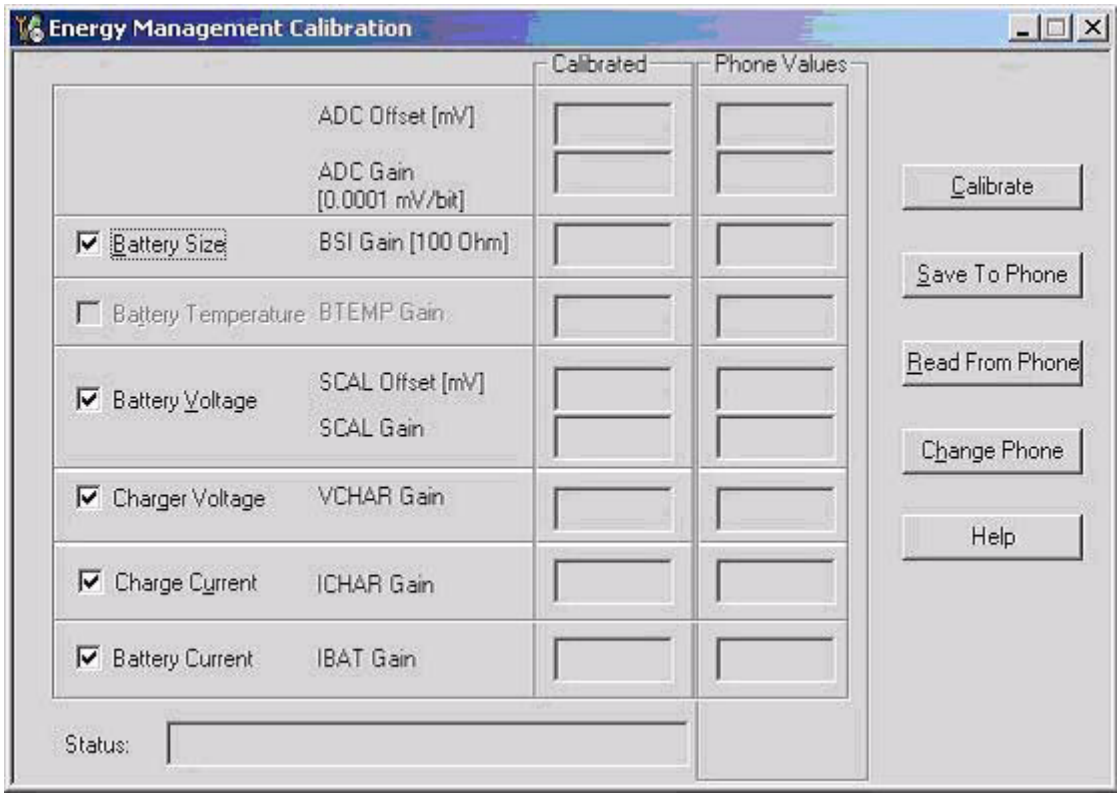
Figure 38: Energy Management Calibration window



Calibration procedure with JBV-1

1 Select Read from phone to display the current calibration values that stored in the phone memory. The values are displayed in the Phone Values field.

2 Select the ADC channel(s) you intend to calibrate.

3 Press Calibrate.

4 Calibration is automatically done regarding the calibration channel(s) that you selected.

5 The candidate of the new calibration values is shown in the “calculated” field. If the new calibration values are within the limit (please refer to the calibration value limit table), Press Save to phone to store the new calibration value(s) into the phone.

6 Select Read from phone to confirm if the new calibration value(s) are stored into phone, correctly. If not, please try to store by selecting Write to PM again.

7 Close the Energy Management Calibration widow.

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Table 2: Calibration value limit

Parameter	Min.	Max.
ADC Gain	25400	29000
ADC Offset	-50	50
BSI Gain	970	1100
VBAT Gain	10000	11000
VBAT Offset	2300	2900
VCHAR	58000	62000
ICHAR	4050	4800
IBAT GAIN	0	255

Zocus (IBAT) calibration with MJ-2 module jig

Zocus (IBAT) calibration can be performed manually with module jig instead of JBV-1.

Connections

The NHL-10 phone must be placed in MJ-2 (Module jig). Two external power supplies and an ammeter are needed.

- Supply 3.7-4.0 V DC from external power supply to module jig.

Phoenix Setup

- Start Phoenix service software.
- Select FBUS connection.
- Choose Main -> Choose product-> NHL-10.
- Choose Tuning -> Zocus EM.

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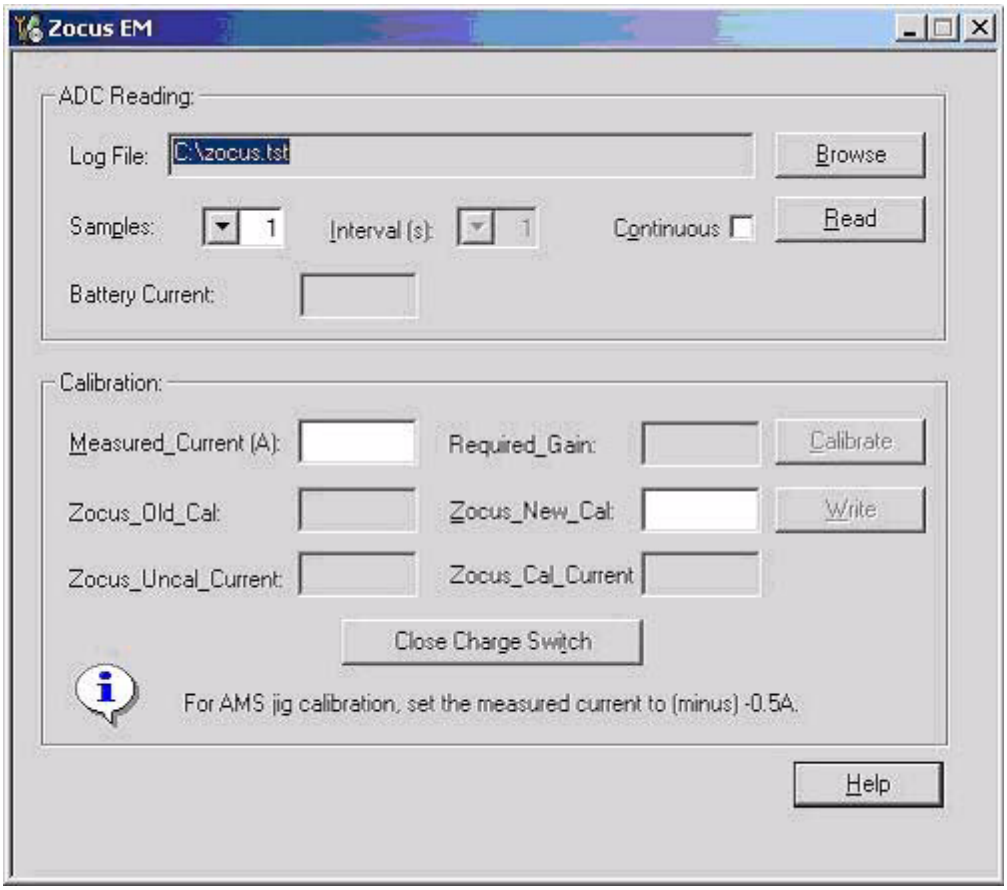
Figure 39: Zocus EM window



Zocus (IBAT) calibration procedure with MJ-2 module jig

1 Place the PWB in the module jig.

2 Connect an ammeter to Ammeter sockets to check the current flowing on the line.
Be careful for the shunt resistor value of ammeter. Large shunt resistor value causes the difficulty of phone power up.

3 Set the S1: Passed and S2: Calibration.

4 Power up the module jig in local mode – the ammeter will indicate the local mode current.

5 Connect the charger input to a power supply set to 8.4V and current limited to 500mA.

6 Turn the power supply on.

7 Open the Zocus EM window in Phoenix.

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8 Press Read in the ADC reading field to confirm the communication between the phone and phoenix is no problem.

9 Press Close Charge Switch.

10 Adjust the current limit on the power supply until the ammeter reads 500mA +/- 5mA.

11 Type the measured current (read this from the ammeter) into the Measured Current box. The value is negative and presented in Amps, e.g. if you measure 502mA, then type –0.502. The reading should be to the nearest mA.

12 The calibration value appears in the box Zocus_New_Cal. To write this to the phone, press Write.

13 Press Open Charge Switch to stop current flowing.

14 Go to the EM calibration window, and then check if the battery current (IBAT Gain) is stored correctly.

Caution: Do not leave the module jig with being "Close Charger Switch" condition for a long time, i.e. 5 min or longer. The transistor used for this calibration on the module jig will get hot due to the current of 500mA.

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